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PAGE'S MAGAZINE

Weekly

ENGINEERING · ELECTRICITY SHIPBUILDING MINING IRON & STEEL INDUSTRIES

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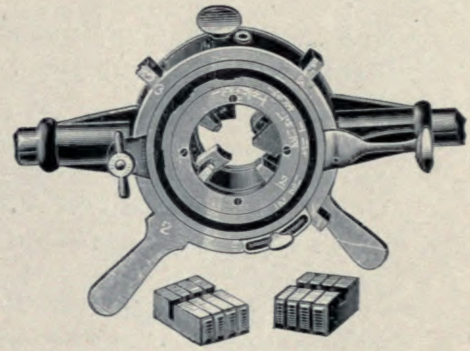
PROGRESS OF THE ENGINEERING WORLD.

THE "**OSTER**" PATENT

STOCKS & DIES

ENGLISH (WHITWORTH) THREADS.

FOR THREADING TUBES, RODS, AND BOLTS.



THE Stocks are made of the highest grade of material, and the Dies of the best special tool steel.

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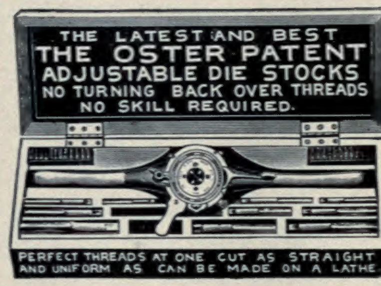

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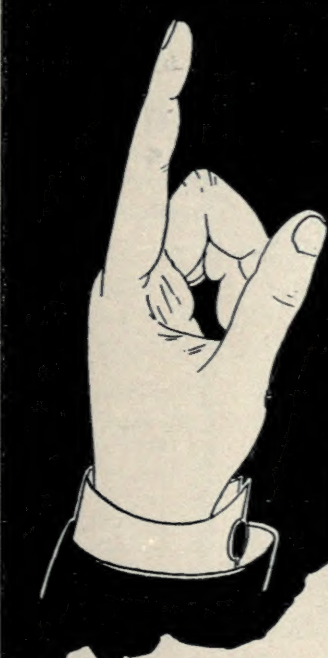

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NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages* 41, 43, 44, & 46.

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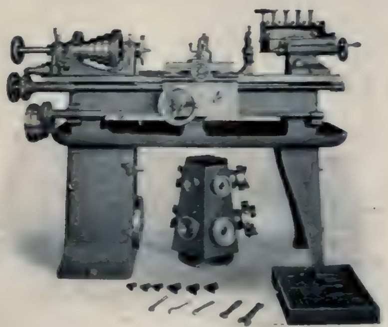
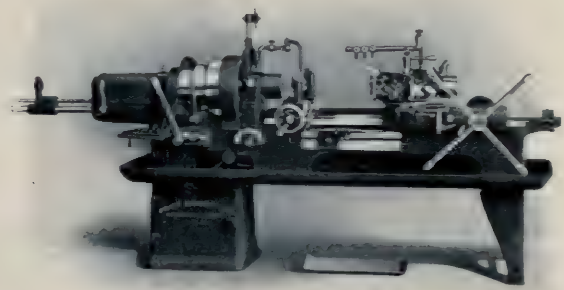
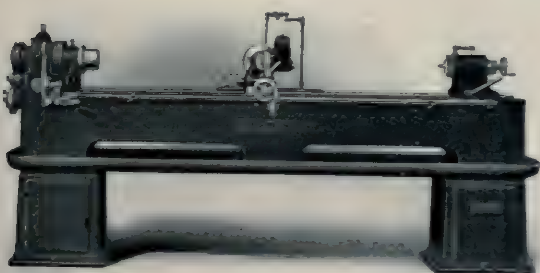


10 in. by 5 ft. Toolmaker's Engine Lathe



2 in. by 26 in. New Model Turret Lathe.
¾ in. by 4½ in. FIVE SIZES. 2 in. by 26 in.
1 in. by 10 in. 1½ in. by 18 in. 3 in. by 36 in.



Thread Milling Machine, 6 in. swing, 80 in. bet. centres.
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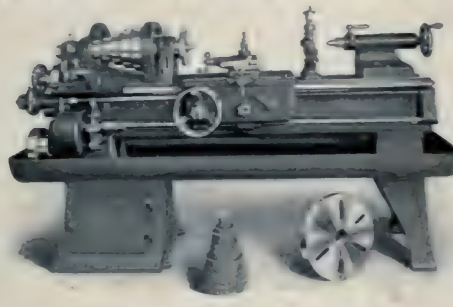
6 in. by 48 in. 6 in. by 132 in.



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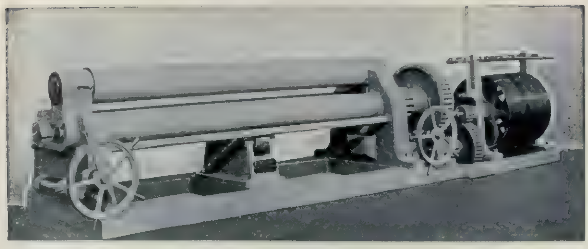

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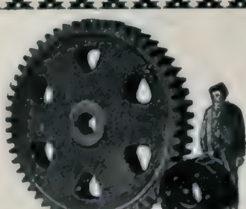

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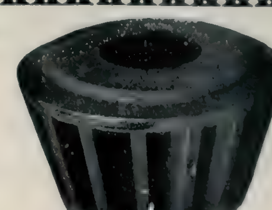

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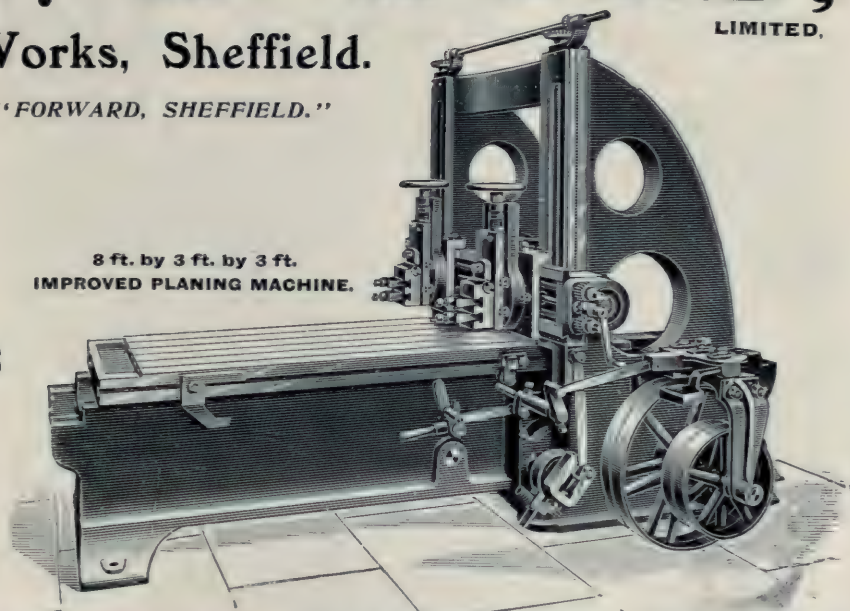

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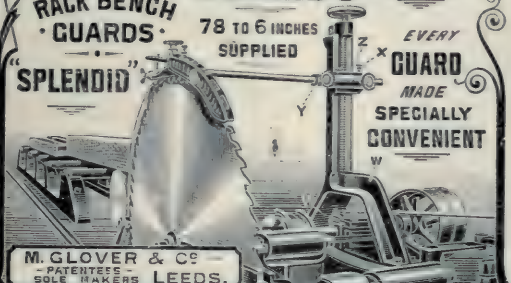

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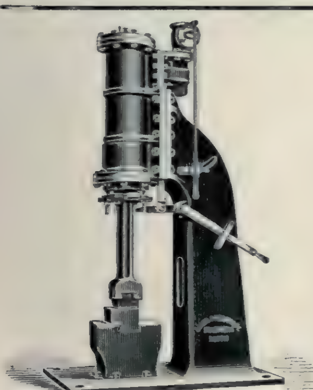

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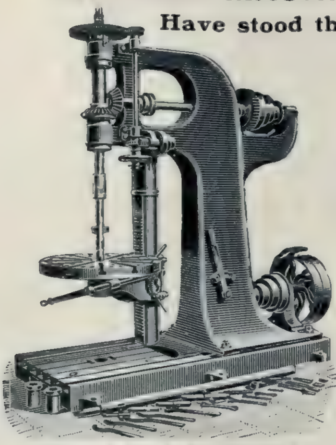

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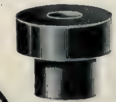

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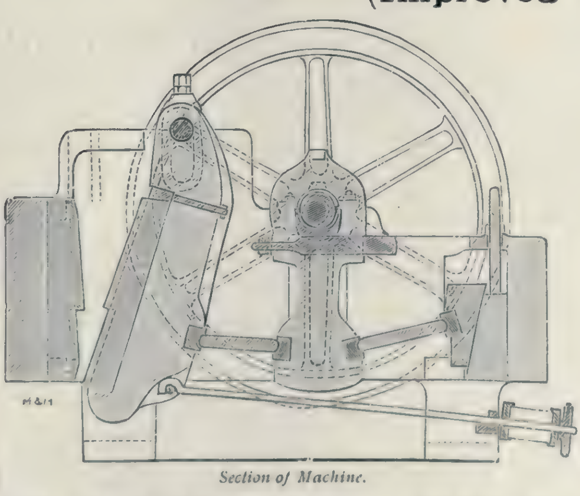

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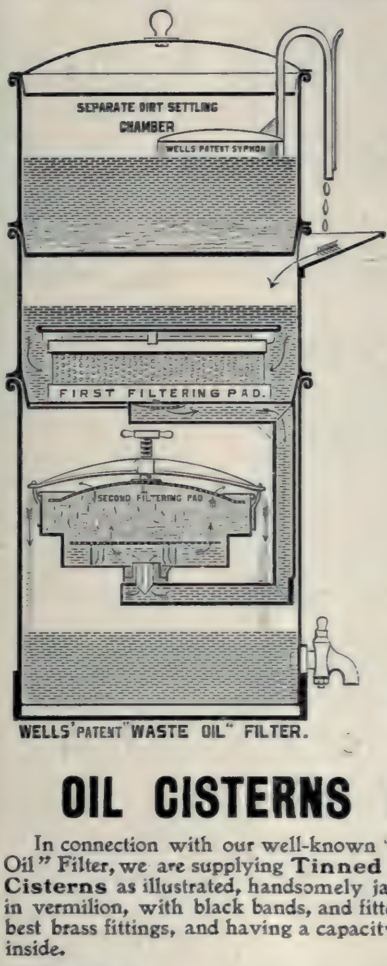

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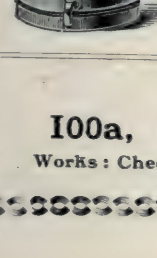

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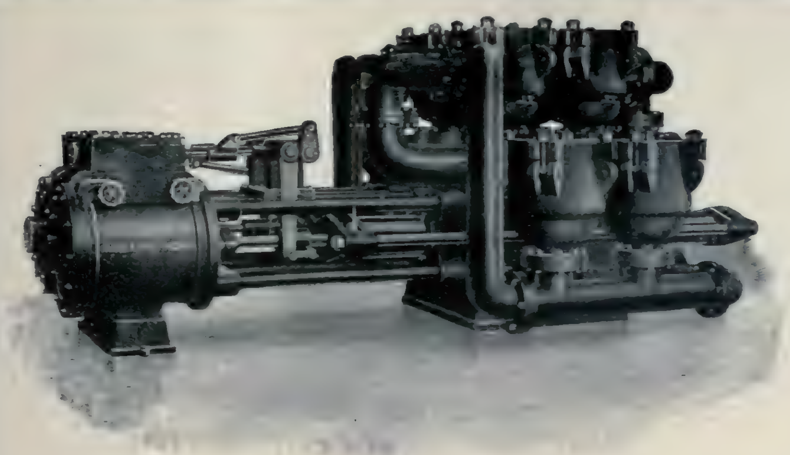

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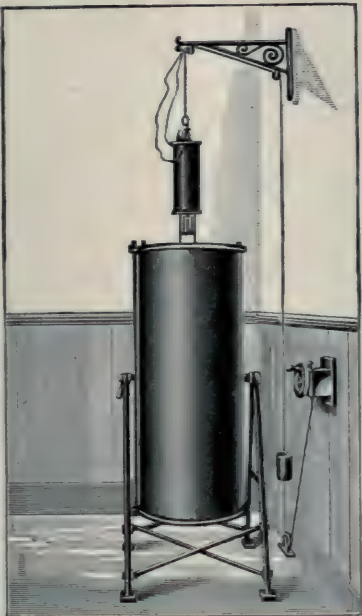

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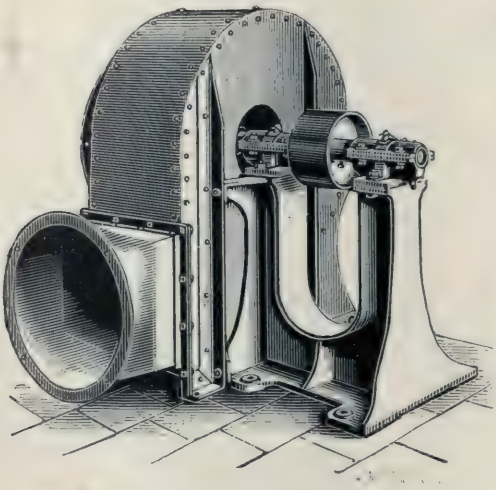

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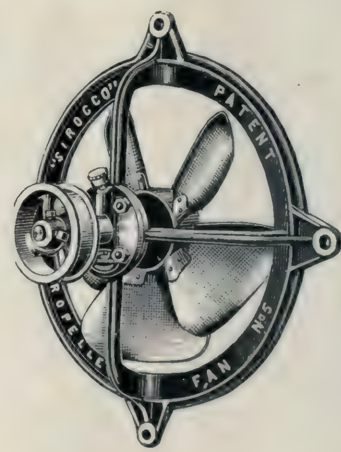

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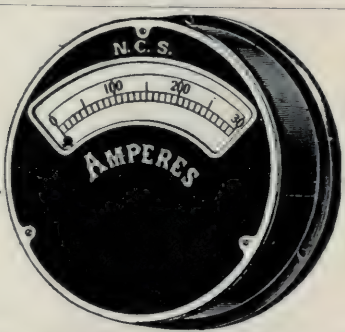

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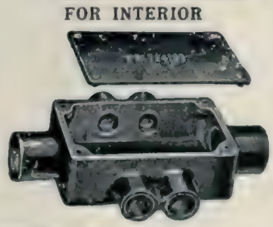

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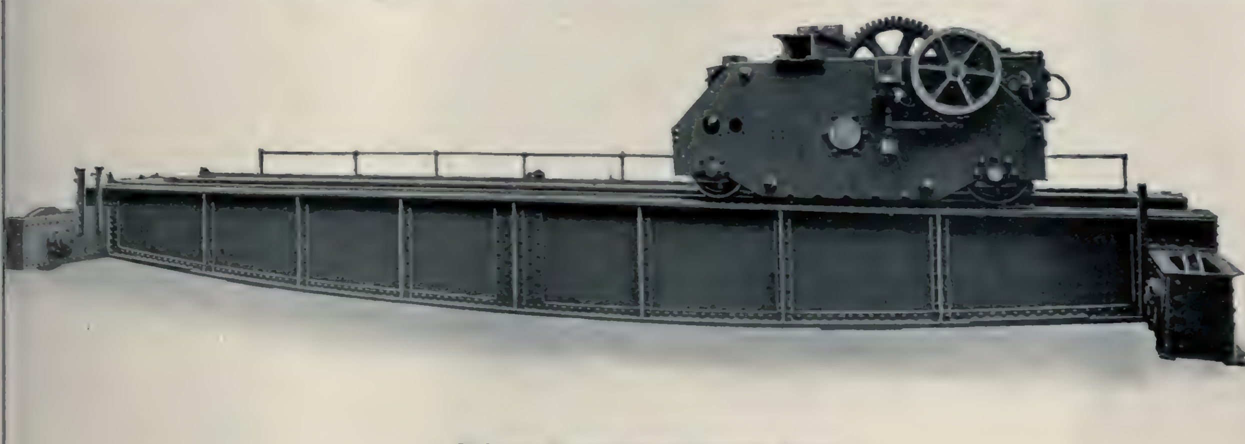

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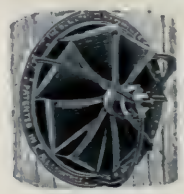

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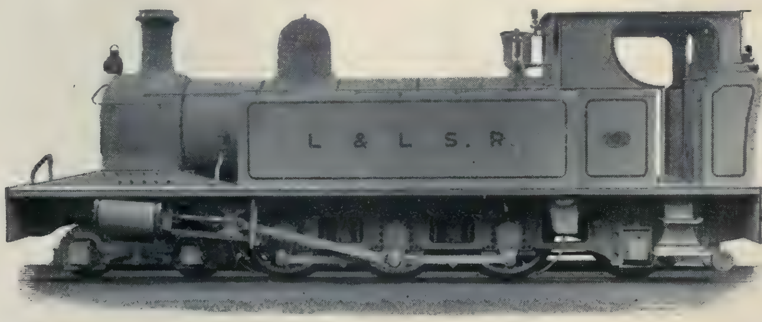

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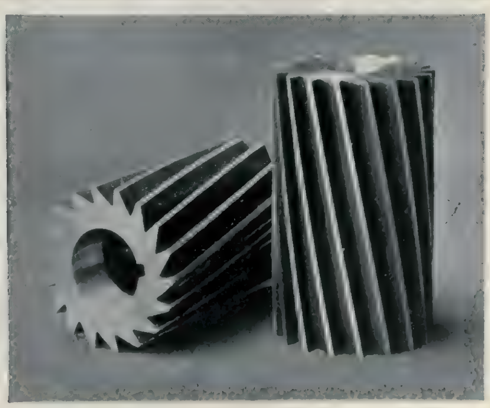

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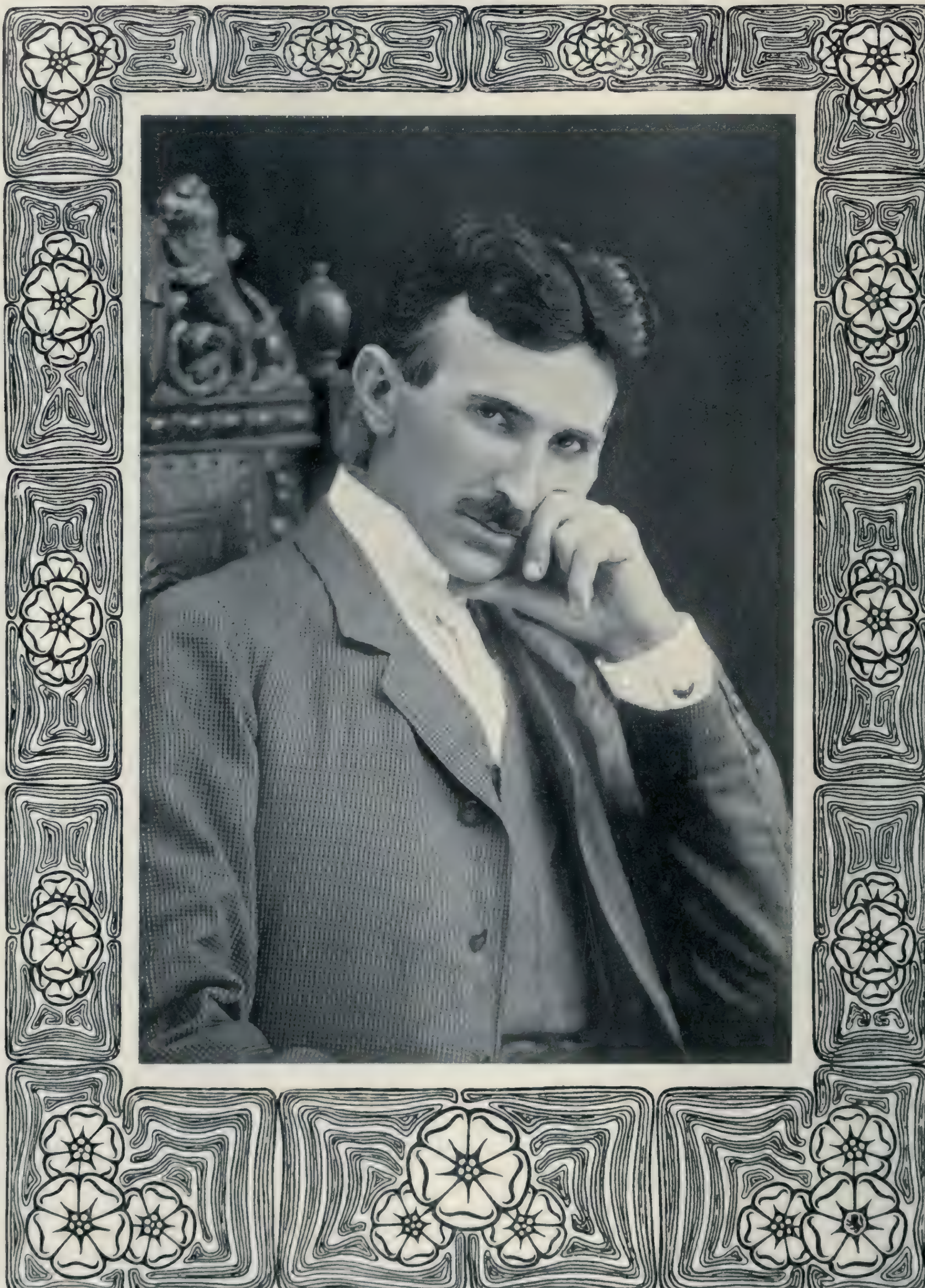


NIKOLA TESLA.

Whose "World Electricity" is referred to on page 31. In sending this picture of himself Tesla writes: "It has been my rule since years not to furnish photographs for publication, but I recognise that I have a great many friends in England who are interested in me and my work. I also appreciate very much your excellent publication."

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. V. LONDON, JULY, 1904. No. 1.

Photo by Author.]

FIG. 3. MAIN VERTICAL DEEP LEVEL SHAFT AT LANCASTER WEST MINE.
Showing headgear, temporary engine house, mullock heap, etc.

THE EQUIPMENT OF THE LANCASTER WEST MINE.

BY

EDGAR SMART, A.M.Inst.C.E.

Continuing his description of notable South African mining enterprises, the author includes in the present article some of the chief points of interest noted during a personal visit to the Lancaster West Mine. A subsequent article will deal with the Boiler House, Engine Room, Double-driven Winding Engine, Electric Plant, Equipment of the Vertical Shaft, etc. Previous articles of the series were: "Developments in Cyanide Practice" (July 1902); "Modern Practice in Milling and Amalgamating" (September and October, 1902); "Collecting Pyritic Material for Cyanide Treatment" (January, 1903); "The Equipment of the Bonanza Mine" (February, 1903); "The Equipment of the Robinson Mine, Johannesburg" (August, September, and October, 1903).—ED.

THIS property is situated at Krugersdorp, about nineteen miles west of Johannesburg, and is under the able management of Mr. John Pascoe, to whom the author is much indebted for his courtesy in giving every facility for the preparation of this article, as well as for the particulars which he supplied personally.

In order to clearly explain the operations which are being carried out, it is necessary to refer to the sketch section shown in fig. 1, in which the known positions and probable extensions of the ore bodies are shown by thick dotted lines, and those of the shafts by full lines.

The mine was originally opened up in a small way on the Battery Reef several years ago, but when acquired by the present company, it was known that the property must also carry the

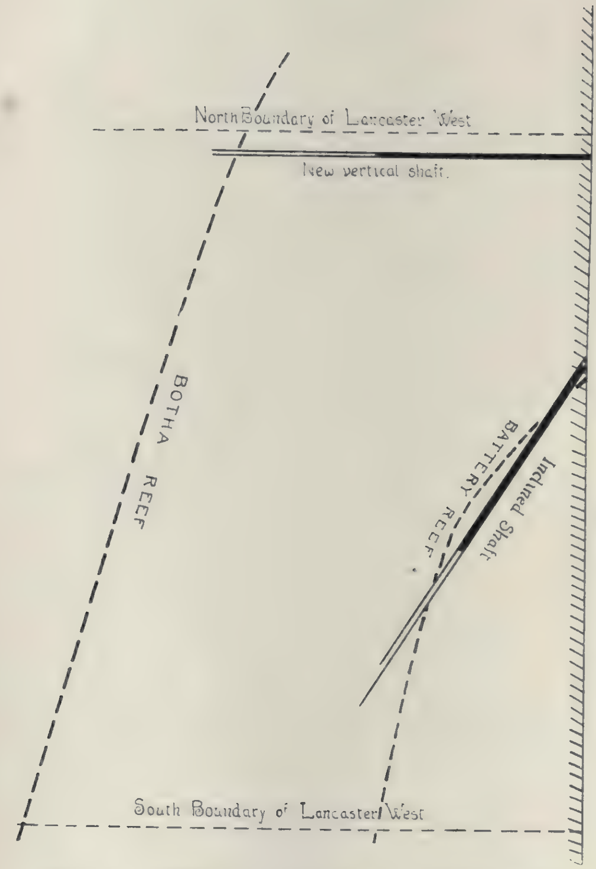


FIG. I. SHOWING POSITION OF SHAFTS AND PROBABLE EXTENSIONS OF THE MINE.

reefs out-cropping to the north of it, more particularly the Botha line of reef. As regards the Battery Reef, therefore, the property is an outcrop mine, but with respect to the Botha reef it is purely a deep level proposition.

MAIN INCLINED SHAFT.

The Battery Reef is now being opened up and worked by a main inclined shaft, sunk at an angle of 32½ degrees, with two subsidiary inclined shafts, which are located 775 ft. to the east and 480 ft. to the west, respectively. The headgear, sorting house, ore bins, and waste rock tram line and dump are shown in fig. 2, together with the brick base and lower portion of the 125 ft. steel stack in the foreground on the left-hand side of the photograph. Besides these bins on the head gear, an ore bin of 150 tons capacity has been provided at each of the shaft stations, from the third to the eighth levels inclusive. There are two advantages arising from this provision for storage at the shaft stations: (1) that stoping and tramming can be carried on simultaneously in all the levels, if necessary, while the ore is being continuously hauled from one bin only until that is empty, and then from other bins in succession; (2) the reserve of ore obviates loss of time in winding due to irregularity in tramming from the passes to the shaft.

The reef is taken out to an average width of 3 ft., and 208,594 tons have been mined from it up to the end of the year 1903. After sorting out the waste rock, the balance, amounting to 175,543 tons, has been crushed, with a total yield from mill and cyanide plants of 66,320 oz. fine gold, or an average value of 7·56 dwts. per ton milled.

The total actual working costs during the year 1903 were only 19s. 6d. per ton milled, and after allowing 5s. per ton for redemption of mine development, the net profit was just over 9s. 10d. per ton milled.

THE VERTICAL SHAFT.

As soon as the Battery Reef had been developed sufficiently to provide such an adequate reserve that milling operations could be commenced, attention was directed to the opening out of the underlying Botha Reef, which is now almost universally admitted to be an extension of the Main Reef series itself, although in the early days before the latter had been traced so far west, it received another name.

The management decided to sink a main vertical shaft at a point 1,150 ft. north of the main incline (see fig. 1), this being about 100 ft. inside the northern boundary of the Company's property. The position of this shaft is particularly mentioned because some of the other deep level mines will be worked by a vertical shaft situated close to their southern boundary, and the question as to which of these locations is to be preferred may shortly give rise to considerable discussion.

The shaft is 23½ ft. by 6 ft. inside measurement, and is divided into four compartments, namely, two at 5 ft. by 6 ft., for hauling ore, one of the same size for men and materials, and one 6½ ft. by 6 ft., for pipes, pump rods, and ladderway. It is timbered with 9-in. by 9-in.

Photo by Author.]

FIG. 2. INCLINE SHAFT, WITH SORTING HOUSE AND WASTE ROCK DUMP AT LANCASTER WEST MINE.

Photo by Author.]

FIG. 4. THE TAILINGS WHEEL AND SERIES OF SPITZKASTEN.

Photo by Author.]

FIG. 5. CYANIDE PLANT FOR SINGLE TREATMENT OF SANDS AT LANCASTER WEST MINE.

pitch pine sets, placed at 6-ft. centres, and is lined with 12-in. by 2-in. lagging. Sinking was commenced in January, 1903, and it is expected that the reef will be struck at a depth of about 2,000 ft., which will require twenty months' work at the estimated average rate of 100 ft. per month. It is intended to continue the sinking through the reef sufficiently for the provision of a permanent ore bin, and also for a main sump. An inclined shaft will then be carried down on the dip of the reef, and the ore will be hauled in this shaft to the above-mentioned bin by an engine at the foot of the vertical shaft operated by compressed air. Thus the hauling will be performed in two separate stages. Similarly, the pumps in the inclined shaft will be driven by compressed air, and will deliver the water into the main sump at the bottom of the vertical shaft, whence it will be brought to the surface by a 12-in. Cornish pump of special design, to be supplied by Messrs. Harvey and Co., who have kindly supplied the photograph shown in fig. 8.

The sinking is being done with a temporary 15-in. by 30-in. double-drum winding engine, which has been erected on the south side of the shaft, so that it will not interfere with the erection of the permanent machinery on the north side. At present steam is provided by two 108-h.p. Büttner boilers, which will eventually constitute part of the permanent power installation. Fig. 3 shows the headgear of this shaft, with the temporary engine house and the beginning of one more of the numerous mullock heaps, which are at once the pride of the miner and the despair of the landscape artist.

STOPING.

In this mine it is still found more advantageous to continue hand drilling in the stopes, because comparatively soft oxidised ore is being worked, and no difficulty has been so far experienced in keeping the battery supplied. An interesting fact in connection with Kafir labour has been noted by Mr. W. M. James, the consulting engineer of this mine, in his report of February, 1903, namely, that under the piece-work system then in vogue, the average work of 195 hammer boys was 4·02 ft. drilled per shift, as against only 3 ft. per shift, which was the maximum established before the war by unwritten law amongst the Kafirs, who were then working on the day wages system.

In connection with this subject, it may also be mentioned that formerly, when the illicit trade in drink amongst the Kafirs was practically

uncontrolled, the manager, Mr. Pascoe, estimates that about 20 *per cent.* of the natives were usually absent from work owing to drunkenness, while during 1902, under the new *régime,* only 7 *per cent.* were absent, including all causes of idleness.

THE CYANIDE WORKS.

Although of comparatively recent construction, this plant differs from the majority of the new installations in that it is designed for single treatment only, and also because no provision has been thought desirable at the present time for the treatment of slimes.

A double tailings wheel, that is to say, a wheel with a set of buckets on each side of the spokes, is situated close to the battery, and the pulp from the tables is lifted by one set of buckets to a launder, which delivers it to a settling pit, with an overflow gate. In this pit the bulk of the sand is settled, and the overflow, containing practically all the slime and some fine sand, passes to the other side of the wheel, which lifts it to a series of spitzkasten, which are shown, together with the wheel, in fig. 4.

The underflow from the spitzkasten contains sand which is returned to the main launder, carrying the pulp from the mill to the settling pits. The overflow from this first set of spitzkasten passes on to a second and larger series, in which the slimes are separated from the bulk of the water, about 75 per cent. of which overflows in such a clarified condition that it can be at once returned to the battery supply tank. The underflow goes to the slimes dam, where the slimes are finally settled and a certain quantity of the remaining water overflows to the pumping station, whence it is returned to the battery.

SETTLING PITS.

The three sand settling pits, each of 500 tons capacity, are enclosed and divided from each other by embankments of earth. At the end opposite to the inflow launder, each pit has an opening cut through the bank provided with a strong timber framing, which carries an inclined gridiron door, hinged at its upper edge to the cross-beam of the frame. A sheet of stout canvas is attached to a spring roller, placed across the bottom of the opening, exactly like an inverted

Photo by Author.]

FIG. 6. THE ELECTRICAL PRECIPITATION TANKS.

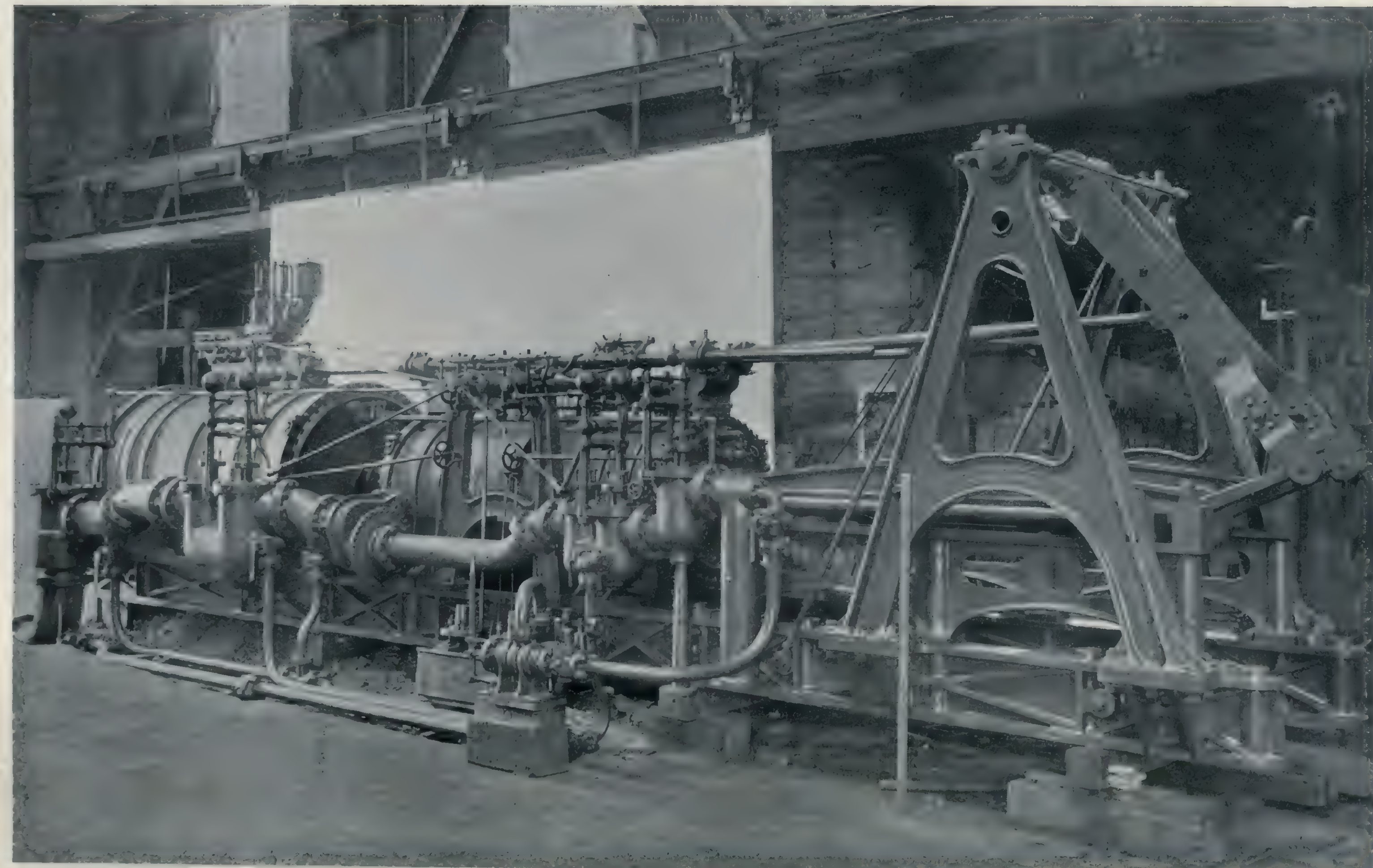


FIG. 8. NEW TYPE OF CORNISH PUMPING ENGINE, BY MESSRS. HARVEY AND CO., FOR MAIN VERTICAL SHAFT LANCASTER WEST MINE, JOHANNESBURG.

FIG. 7. NORTHERN PORTION OF SURFACE PLAN, LANCASTER WEST MINE.

(The only feature of interest in the southern half of the plan is the explosives store.)

window blind. The upper free edge of this blind forms the overflow for the slimy water from the pit; it is pulled up a few inches higher from time to time, as the collected sand accumulates behind it, and it rests against the gridiron door above mentioned. When the pit is full of sand, the grid and blind are lifted together out of the way, thus leaving free access to the tailings therein, and the sand is shovelled into trucks, which can enter the pit as the excavation proceeds. The trucks are then hauled up to the top of the treatment vats.

In this way 71 per cent. of the material rushed is collected in a leachable condition for cyanide treatment, which is a very good result for pit settlement, but in order to reduce the cost of handling the tailings at this stage, it is intended to erect collecting vats on piers, with tunnels underneath the vats, in order to have the economical advantage of a bottom discharge. These will be built in line with the treatment vats, and on the same level, instead of being placed over the latter as in many other plants.

There are eight steel treatment vats, 30 ft. diameter by 8 ft. deep, built on stone piers in two parallel rows of four vats (fig. 5). The type of plant with collecting vats and treatment vats on one level and in one straight line,

although one of the earliest forms adopted on the Rand, is likely to come into use again largely in the future for either single or double treatment, but with a continuous belt for transfer of the material from one set of vats to the other, in place of the inclined tram line, and truck haulage. The two salient advantages of this system over the double tier plants are: first, an economy in cost of construction; and, second, a greater latitude in the handling of the tailings for transfer from the first to the second set of vats.

For with the single tier plants, the contents of any vat of the first set can be readily transferred to any one of the second set, so that the number of vats in each set need not be equal, but may be proportional to the times occupied in the two stages of the treatment.

It may be observed also that any number of sets of vats may be arranged in the same way for the collection of tailings followed by single, double, or *triple* treatment, as desired.

PRECIPITATION HOUSE.

The Siemens' electrical precipitation process is still in use at this mine, and fig. 6 shows the arrangement of the precipitation boxes.

Each of the four boxes is 31 ft. long, 5 ft. wide, and 5 ft. deep, and contains 156 iron anode plates, 4 ft. by 2 ft. in area. The total anode surface is, therefore, nearly 10,000 square feet. The gold is deposited on the lead foil cathodes, which are melted and cupelled in the usual manner. The electrodes are connected in multiple series, and the current density allowed is 0·04 ampere per square foot. The amount of cyanide solution dealt with in this plant averages 150 tons per day.

THE SURFACE LAY OUT.

Fig. 7 is reproduced from a surface plan issued with the Company's reports, for which the writer is indebted to the courtesy of Messrs. A. Georz and Co., and the Secretary of the Company, Mr. F. W. Diamond. It shows the position of the shafts already referred to, and also illustrates the general arrangement of the surface plant of a property whose equipment is sufficiently recent to have received the benefit of experience gained on the earlier mines.

Thus the service reservoir, which has a capacity of three million gallons, is placed on the highest point of the ground, so that water can be supplied from it for domestic as well as mining purposes, on all parts of the property by gravitation.

It may be noted, too, that the mill, according to the usual and best practice, is situated near the main shaft, but it is *north* of the outcrop, the latter point having often been neglected formerly in the selection of sites for batteries, which, having been built over the reef, have suffered considerable disturbance when the ore beneath them was removed.

The engine and boiler houses are as usual close to the mill, the workshops handy, but a little further removed. The concentration of all these buildings and the cyanide plant and offices within a small area, reduces the labour of managerial supervision to a minimum, and facilitates the communication between the various departments necessary for their due co-operation.

The arrangement of the residential buildings is, of course, largely a question of taste, but it may be pointed out that the houses for the white employees are grouped on the rising ground on the western side, while the Kafir compound is placed as far away as possible near the eastern boundary, an arrangement equally satisfactory to both colours.

(*To be continued.*)

Portable Steam Engines of To-Day.

BY

J. C. R. ADAMS.

In the present article the author discusses some of the theoretical considerations which have played an important part in the development of the portable steam engine. A subsequent article will be devoted to leading types of these engines.—ED.

THE characteristic essential of the portable engine—or, as it is more conveniently designated, the locomobile—is naturally its portability; and, as we shall see in a moment, this condition is not altogether satisfied by the fact that it is mounted upon four wheels like any other heavy vehicle.

The motto of the locomobile is *Ubique*, and its work lies, not seldom, at the very outposts of civilisation, so that, instead of the engine following the roads, the road may be very literally said to follow the engine. Forests have to be cleared, swamps drained, bridges of stone or timber constructed, and rocks blasted and broken up for road-metal before vehicles can travel in a civilised and decorous manner.

Conveyance upon its own wheels, as it nears the end of its journey, is sometimes impossible, and there is nothing for it but to dismount the engine from the boiler, and carry the separate parts bodily, by sheer force of human labour.

Stripped of everything which can be taken from it, the boiler has to be floated across streams, lashed to timbers and supported by empty casks, to give it buoyancy. In passing, it may be useful to note that small locomotive-type boilers are too heavy in proportion to their volume to float without assistance. even when all openings are sealed up. Before now a boiler of this kind has been built up solid with timber into a cylindrical form, and rolled up a mountain side, or lowered down a precipice, in the manner adopted by the brewers' drayman.

TRANSPORT DIFFICULTIES.

Fig. 1 shows a quaint procession "assisting" the boiler of a portable engine along a mountain path in China, and illustrates some of the difficulties met with in transport. In more serious cases, it sometimes happens that the entire machine has to be transported in small pieces, each forming a load for one or two men. Here, however, the ordinary portable engine, because of its heavy unit, the boiler, fails utterly, and recourse must be had to a water-tube boiler, which, conveyed in single tubes, can be taken up a ladder if necessary. But this is by the way.

THE DETACHABLE ENGINE.

The principal modern improvement in the locomobile which concerns us just now is the detachable engine. Under the old system, the cylinder is curved to fit the boiler, and is secured to it by bolts passing through the boiler-plates, while the "saddle" or casting comprising the two plummer-blocks for carrying the crank-shaft. is also curved to suit the boiler, and attached by more bolts. This method of construction strikes us at once as offering at least two disadvantages—one, the obvious liability of leakage through any one of the sixteen bolt-holes passing through the shell of the boiler, and the other the fact that the cylinder is, so to speak, specialised, in that it is individually fitted to the curve of the boiler, and therefore cannot be replaced, if injured or worn out, without the services of a skilled erector. The same objections apply, of course, but in an even greater degree, to the cast-iron saddle, with the additional disadvantage that the latter is particularly liable to breakage when the engine is stripped for travelling under the circumstances illustrated in fig. 1.

There is one more accusation to be brought against the cast-iron saddle while we are on the subject, and that is the obvious want of a direct connection between itself and the cylinder, to take up the stresses induced by the pull-and-thrust of the piston upon the crank. As it is, these stresses are conveyed through the boiler—not a desirable thing in itself, although the boiler, in small portable engines, at any rate, is strong enough to form the frame of the engine without injury. The chief objection to this arrangement is the possibility of its giving rise to leakage at the bolt-holes already mentioned, unsuspected and unseen until the removal of the cleading (or sheathing of non-conducting material which covers the boiler) discloses an

FIG. I. ILLUSTRATING TRANSPORT DIFFICULTIES IN CHINA.

unwelcome spectacle—the wasting away of the boiler-plate, in the wake of some one or more of the bolt-holes—a defect not easily remedied.

Owing to the expansion and contraction of the boiler, as it is alternately heated and cooled,

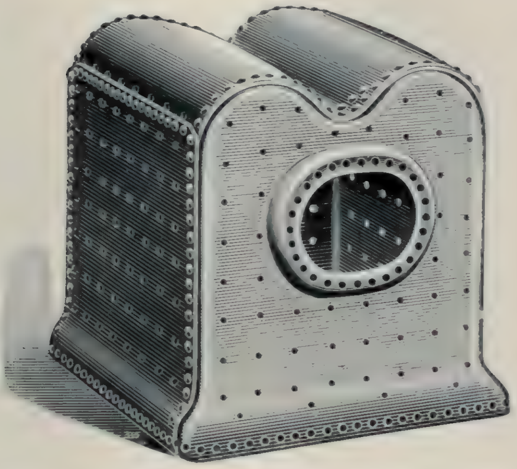


FIG. 2. CORRUGATED ROOF-PLATE OF MESSRS. RICHARD GARRETT AND SONS, LTD.

anything in the nature of a rigid connection between cylinder and saddle is out of the question, as it would give rise to stresses beyond comparison greater than those it was intended to absorb.

This brings us to the method now almost universally adopted for rigidly connecting the cylinder and crankshaft bearings, while allowing for the free expansion of the boiler—the sliding plummer-block. Upon the steel-plate brackets riveted to the boiler-barrel, cast-iron fitting-pieces are bolted, upon which the plummer-blocks are free to slide longitudinally by means of a dovetailed rib or its equivalent.

A steel tie-rod connects each plummer-block with its own side of the cylinder, the latter being rigidly fixed to corresponding brackets riveted to the firebox casing. This is the general principle of the detachable engine, carried out in differing detail in the engines we shall illustrate.

This allows of a complete and independent horizontal steam-engine being erected with all its parts separately upon a surface-plate, with all its bolt-holes drilled to template, without reference to the particular boiler it may be connected up to. From this it follows that, in the event of serious damage to the boiler, as, for example, the not unknown case of a fire being lighted without the boiler having been previously filled with water, a new boiler could be sent out with the certainty of fitting correctly to the existing engine. Conversely, any details required for the repair of the engine, or the complete engine itself, can be ordered without fear of any difficulty in its erection upon the boiler.

If circumstances require it, the engine and boiler may be dissociated, and put to work in separate rooms or placed side by side. Only those who have been in charge of steam-driven machinery in situations far removed from the possibility of obtaining skilled mechanical labour, can fully appreciate the marvellous adaptability of the portable steam-engine, in its modern form, as illustrated in the course of this article. True economy in steam consumption is only attained by making the working parts strong and stiff enough to withstand the stresses induced by an early cut-off in the cylinder with a high initial steam-pressure—otherwise, the benefits of expansive working are more than neutralised by endless trouble caused through bending stresses in the engine parts, leading to hot bearings and other difficulties.

LOCOMOBILE BOILERS.

The boiler of the locomobile nowadays is always constructed of steel, and is, as a rule, an admirable specimen of good design and accurate workmanship. So far as we have been able to ascertain, there are only two variations from the normal construction in general use, which we shall consider in due course. Neither of these, however, affects the general principle of the boiler. The material is, as we have said, steel, but as that convenient appellation covers a very wide field, it will be necessary to define the quality and grade of the steel which it is desirable should be employed in a first-class loco-type boiler.

Boiler-shell plates should have a tensile strength of not less than 26, or more than 30 tons per square inch of section. A sample of Siemens-Martin steel, of thoroughly satisfactory character, gave the following results: Ultimate tensile strength, 27·9 tons; elongation in 8 in., 26 per cent.; contraction of fractured area, 47 per cent. A strip of this plate, heated to a cherry-red, and plunged into water at 80 deg. F., may be doubled over flat upon itself without any indication of cracking. The drifting test shows that a $\frac{5}{8}$ in. hole may be enlarged, cold, to $1\frac{5}{8}$ in. diameter, without distress of the plate.

An analysis of the same piece gave carbon ·16 per cent.; silicon, ·018; sulphur, ·035; phosphorus, ·066; manganese, ·492 per cent. A similar analysis of firebox plate gave carbon, ·16;

silicon, ·022; sulphur, ·032; phosphorus, ·05; manganese, ·479 per cent. This plate showed 25½ tons tensile strength; 28 per cent. elongation in 8 in., with 48 per cent. reduction of fractional area.

In rivet steel, the tenacity is 26 tons, but the ductility is greater, the elongation in 8 in. being 31 per cent., with a contraction at fracture of 66 per cent. Rivets should admit of being doubled over flat, cold, and the head should allow of being flattened out, hot, to ⅛ in. thickness, without cracking at the edges.

The flanging of the plates should be entirely done by hydraulic pressure, and all the rivet-holes should be drilled in position, the plates being afterwards separated, and the small burrs produced by the drilling (which would interfere with the close contact of the plates) removed. Plates which have been locally heated for any purpose, should not be put into the boiler until they have been annealed, which has the effect of setting the plate at rest, or, in other words, of eliminating all local stresses induced by partial heating.

Finally, hydraulic or machine riveting should be employed throughout, a variety of special portable riveting machines now being available, capable of dealing with difficult positions.

The manhole should, of course, be adequately reinforced by a strengthening plate riveted round it, and the manhole door should be of pressed steel, preferably of that kind which has a flat joint, rather than one which follows the curve of the boiler. As a rule, however, in dealing with any firm of good repute, there is little need to go beyond their own standard of material and workmanship, which will be found adequate to the requirements of any boiler-insurance association.

The rules for the strength and staying of loco-type boilers are too complex for discussion here, but it may be taken for granted that, if the boiler stands an hydraulic test of 100 lb. per square inch above the ordinary working pressure (usually 100 lb. per square inch) without distortion or leakage, there will be little fear of faulty workmanship or bad design escaping detection.

Now, in regard to size of boiler, we may, in single or double cylinder non-compound portable engines, allow for a maximum steam consumption—or, in other words, a water evaporation—of 40 lb. per effective h.p. per hour, and at a piston-speed of 300 ft. per minute, may fix a diameter of cylinder. These two factors will enable us to tabulate various dimensions of the boilers corresponding to given cylinder diameters.

This table, which has been compiled expressly for this article from the practice of several of the leading makers, will be found useful as a check upon the size and power of the boilers, Thus—for single-cylinder engines the boiler dimensions may be as follows:—

SINGLE-CYLINDER ENGINES.

Cylinder Diameter.	Grate-area.	Heating Surface.			Effective or Brake h.p.
		Firebox.	Tubes.	Total.	
in.	sq. ft.	sq. ft.	sq. ft.	sq. ft.	
6½	3	14	54	68	10½
7	3¼	15½	61½	77	11¾
7½	3¾	18½	76	94½	14
8½	4½	23	98	121	17¾
9	5	25½	112½	138	20½
10	5¾	30	134	164	25
10¾	6½	34½	156	190½	29½
11¾	7¼	39	178	217	35
12¾	8	43	200	243	40½

DOUBLE-CYLINDER ENGINES.

9	8¾	48	218	266	45
10	10¼	56½	256	312½	55½
10¾	11½	63½	288	351½	64
11¼	12	65	300	365	70
12	13½	74	338	412	80
13	15	82½	375	457½	94

For wood-burning boilers the tabulated grate-area should be increased by approximately 25 per cent., which is also adequate for burning straw.

The firebox heating surface will consequently be enlarged to nearly the same extent, the tube surface remaining unaltered. Without going more minutely into boiler measurements, the above may be taken as fairly representative of the boiler sizes which accompany the given cylinder-diameters.

ROOF-PLATE PROBLEMS.

In general construction there is very little difference between the boilers as manufactured by the various leading makers. We have mentioned two specialities which form almost the only exceptions to the ordinary design; both consisting of improved methods of supporting the roof of the firebox. It may be worth while to explain the ordinary method of doing this, and the need for improvement which undoubtedly exists. Few persons, other than those interested in the design or manufacture of loco-type boilers, realise the pressure which has to be sustained by the roof-plate of quite a small portable engine boiler.

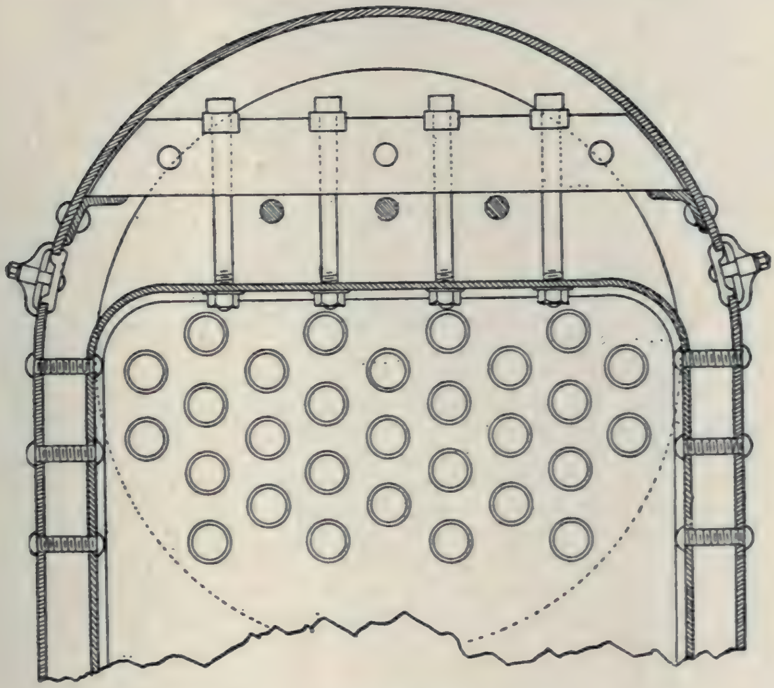


FIG. 3. MESSRS. ROBEYS' SOLUTION.

To make up for this by thickening the tube-plates would, if carried out completely, result in a plate of such thickness that it would become over-heated.

The second obvious disadvantage of the ordinary roof-girder system is that the space between them and the roof-plate—usually not more than about an inch—becomes, owing to the difficulty of cleaning, filled up solid with scale or deposit, thus causing over heating of the roof-plate. It should, perhaps, be explained that the plates of a firebox, unless in actual contact with the water, soon reach a temperature at which the strength of the plate is seriously impaired.

There are three methods of overcoming this difficulty, one of which, illustrated in fig. 2, is the corrugated roof-plate of Messrs. Garrett. In this the absence of incrustation and freedom from the collection of mud on the crown (owing chiefly to the absence of the usual tangle of crown-stays) are also two very noticeable features. The natural expansion and contraction are alone sufficient to prevent incrustation, as any thin coating of mud or scale which may collect is immediately broken on the next occasion of any change of temperature (with the consequent alteration in area and form of crown-plate), and carried away by the violent ebullition which takes place above this—the hottest—portion of the firebox, to settle ultimately in a specially-designed mud-pocket, from which it is easily removed. In addition to these two good points of extreme durability and strength, the firebox has also the advantage of being the most efficient, as, owing to its form, it contains more heating surface than any other firebox of similar grate-area. The pocket between the corrugations may really be described as the lower and more efficient half of a water-tube, situate in the midst of the hottest gases of combustion.

Take, for example, that tabulated for a 10-in. single-cylinder engine, 5·75 square feet of grate-area. Adding the 25 per cent. extra for wood burning, we have 7·19 square feet as the area of the roof-plate. At 100 lb. steam pressure per square inch, we have 14,400 lb. pressure per square foot; and 103,536 lb., or more than 46 tons, as the total downward pressure to be resisted all the time the boiler is at work.

How is this considerable pressure, which would crush in a flat roof-plate instantly, to be provided against? The usual plan is to provide a sufficient number of roof-girders, resting at their ends upon the vertical end-plates of the firebox, and upon the portions of the roof-plate immediately contiguous, the latter being hung up to the girders by stay-bolts at a pitch, or distance apart, carefully proportioned to the load each bolt is capable of carrying safely. The immediately visible defects of this arrangement, which, nevertheless, is the one adopted in the vast majority of loco-type boilers, are, first, that the whole of the stress is transferred to the end plates of the firebox; one of which, the tube-plate, is so much weakened by the large area cut out of it by the tube-holes, that a much greater stress than is desirable is imposed upon the solid portions of the plate between the holes.

Messrs. Robeys' solution of the problem is shown in fig. 3, and consists in principle of transverse roof-girders, carried (at a height above the firebox crown-plate of some six or eight inches, to allow of free access for cleaning)

by two brackets, or angle-irons, riveted to the shell of the firebox. As these girders are evidently free to lift with the expansion of the firebox, elasticity is secured, while the entire weight (the forty-six tons, for example, already mentioned) is carried by the external, or firebox shell plate, thus relieving the foundation ring from the liability to leakage always present when it has to take the pressure due to the area of the firebox.

The third method of eliminating the usual roof-girders is that of sling stays. In this system the roof of the firebox is curved, and the screwed stays are carried right up to, and screwed through, the external firebox-plate. This arrangement is seldom, if ever, used in portable engine boilers, and may be dismissed with the mention of two incidental disadvantages —first, the fact that they are screwed through both plates at an angle which is a compromise between the radial directions of two differently curved plates, with the consequence that they pass through both at an unfavourable angle, and, secondly, that there is no elasticity about it. When the inner firebox expands upwards through heat, which occurs before the external box becomes heated to the same degree, an enormous compressive strain is exerted upon these sling stays, tending to force them through, and loosen them in, the screwed holes through which they pass. From all this it will be seen that there are many things to be considered, even in the supporting of the firebox crown of a small portable engine boiler.

BOILER-SHELL CONSTRUCTION.

There are two differing forms of loco-type boilers in use at the present day, each having its own special advantages in connection with the portable engine. These are the straight-line (or "flush-topped") boiler, and the saddle boiler. The latter takes its name from the saddle, or flanged junction-plate uniting the barrel, or cylindrical part of the boiler, with the firebox casing. As a consequence of this construction, the barrel is some two and a half or three inches smaller all round than the arched top of the firebox casing, but as there is still room to accommodate as many tubes as the breadth of the inner firebox allows of, there is no restriction of the heating surface owing to the lessened diameter of the barrel.

This pattern is a favourite one with portable engine builders, as when the crank-shaft is fixed at such a height that the crank just clears the barrel, the superior height of the firebox casing is exactly adapted to receive the cylinder; engine and boiler thus affording an example of mutual accommodation. The disadvantage of this system is naturally the set-off in the outline of the boiler, giving longitudinal elasticity to the structure. This effect, however, can be, and, of course, always is, resisted by an adequate provision of longitudinal stays extending from end to end of the boiler, usually plain steel tie-rods fitted with inside and outside nuts, and generally screwed through one or both the end plates. The use of this boiler is in practice mostly confined to the smaller sizes, for which it is in every way admirably adapted.

The straight-line boiler, of which Messrs. Clayton's and Messrs. Turners' engines (to be illustrated in a succeeding article) give examples, has its barrel-diameter equal to the width of the external firebox, and is usually spoken of as the "flush-topped" type. Most of the makers adopt this pattern for their larger sizes, its increased capacity of barrel giving more steam room and greater facilities for entering and cleaning the boiler.

Longitudinal stays are, of course, still necessary, but are mainly for the purpose of strengthening the end plates, viz., the smoke box tube-plate, and the upper part of the firebox front-plate. In general, boilers of more than 12 or 14 nominal h.p. should be constructed on the straight-line principle.

(*To be continued.*)

The Daft-Williams Electrical Ore-Finding System.

DEMONSTRATION AT THE WESTMINSTER PALACE HOTEL.

IN April, 1903, we were able to call attention to the possibilities of the electrical ore-finding system invented by Messrs. Leo Daft and Alfred Williams.

At a well-attended meeting recently held at the Westminster Palace Hotel, Mr. Andrew Anderson in the chair, a practical demonstration of the working of the apparatus was given by Mr. Williams, and Professor Sylvanus Thompson, D.Sc., F.R.S., described the results of experiments lately made by him in Wales.

Mr. Alfred Williams, in his paper, entitled "The Application of Electricity to the Location of Metalliferous Deposits," showed that early attempts to locate ore bodies by methods depending upon earth resistance had not been successful. He experimented with this method in 1890 and abandoned it as futile.

THE ORIGIN OF THE SYSTEM.

During his series of magnificent experiments some twenty years ago, Sir William Preece energised the earth with an interrupted current of low potential for wireless telegraphy purposes, and studied the lines of flow with a telephone circuit connected to earth by portable electrodes. During this work he noticed that the geological conditions of the earth's crust, through which his currents were flowing, altered the shape and changed the intensity of his field. It is to this observation that the inception of the present system of ore finding is due. Experiments were made by connecting the secondary of a small induction coil to earth in the neighbourhood of an artificial lode, and the results were so encouraging as to warrant attempts on a larger scale. During a prospecting expedition in 1899 to the Alexandrian Archipelago, off the Alaskan coast, Mr. Williams experimented with a small coil worked from dry cells, and delivering a secondary current at about 200 volts. The results obtained justified the most sanguine expectations. Mr. Leo Daft at once designed coils to deliver very sharp peaked waves of variable potential and receiving telephones of special qualities. A great many experiments were carried out in Alaska and British Columbia, which proved beyond doubt that ore bodies could not only be traced by this method, but that unknown lodes could be discovered.

THE APPARATUS.

The present apparatus is the outcome of several years' constant testing in the mining field with practically every variety of wave form and length. Mr. Daft designed about forty different types of instruments, which were tested continually at various mines, and the system was perfected for practical work.

The transmitting apparatus consists of an induction coil adapted to deliver, when required, a very heavy secondary discharge into a glass condenser, from which

METHOD OF USING THE APPARATUS.

wires connect to portable electrodes. Two spark gaps —in series and parallel—are inserted in the circuit, which is completed by the earth. The breaks are of two types; one operated by an electric motor delivering a quick hammer-like blow with platinum contacts in alcohol; the lower electrode being mounted on a revolving table and held in position by a strong spring. The upper electrode strikes sharply, and, on making contact, forces the lower one downwards. On the return stroke the contact is broken at any point desired by the lower electrode's upward movement, caused by the pressing spring, being suddenly arrested by contact with the point of a rod, the position of which is adjustable. This break is far superior to any other form for this purpose, giving a "make" of any desired length, and a "break" of unusual abruptness. The second form of "break" is of the pendulum type, and on account of its simplicity is well adapted to short distance working, or in places where it is necessary that the instruments should work for several hours without an attendant—as sometimes occurs in remote districts.

The receiving circuit consists of two telephone receivers each of 500 to 900 ohms resistance, connected to the exploring electrodes through a series-parallel switch.

ITS APPLICATION.

On earthing the transmitting electrodes—usually about 100 yards apart—a field of force is created in the earth's crust something similar to an exaggerated field of force from a large horse-shoe magnet. With a suitable amount of condenser in action, and proper adjustment of the spark gaps, the telephones, connected to the receiving electrodes immersed in the earth about 70 ft. apart, give an audible note at least a mile away. With longer transmitting lines and a primary energy of 100 watts, sounds are easily audible two miles away even when the receiving electrodes are only 150 ft. apart. There is no limit, practically speaking, to the distance to which the field can be thrown when desired, but in most cases it is unnecessary to energise more than a radius of half a mile. With a normal field—undisturbed by lodes—the direction of the lines of flow through the earth is approximately in accordance with the theoretical diagrams as shown in text-books.

Now we come to the question of the variations from the normal, caused by underground deposits of metalliferous bodies. Lodes are electrically divided into two classes, those which are better conductors than the enclosing rock, and those which are, comparatively speaking, insulators. A good conducting lode changes the shape and intensity of the normal field in a remarkable manner—elongating it in the direction of the strike. Waves passing into the lode at great depths are brought up to the surface. Hence, over the apex of the lode there is a concentration of energy and a corresponding increase of the sounds in the telephones when in the neighbourhood of the lode. In this way the position of the lode is easily ascertained, and, on exploring with the receiving electrodes further and further away, no sounds are heard whatever, except over the path of the lode, and by moving the electrodes, a point is found where the sound suddenly ceases in some cases, but is again audible on moving the electrodes a little further. This point of equipotential and consequent silence occurs when the electrodes are so placed that the apex of the lode is midway between them. Absolute silence is not invariably attained, but in the case of conducting lodes, a diminution of sound always occurs. If the operator is nearer to the transmitting base and is receiving some of the normal waves which are travelling on and near the surface at an angle to the direction of the lode's strike, a cross field is observed when the lode is between the electrodes, and the telephones give broken and discordant sounds.

With lodes which act as insulating bodies, the field is never elongated, but possesses its normal shape. The waves, on encountering the lode, are brought to the surface of the ground on account of their inability to pass through, and, consequently, are all concentrated in the space between the apex of the lode and the earth's surface. When the telephone electrodes—being moved across the field at right angles to the direction in which it is expected the ore bodies strike—arrive at a point over a lode of this kind the increase in sound is sudden and intense, as might be expected when we consider the great depths from which the insulating body causes the waves to be brought.

A lode where metal occurs in shutes or vertical deposits, but otherwise insulating, gives most interesting reactions, the effects obtained over the shute representing miniature fields which locally dominate both the normal field and the narrow concentrated field caused by insulating portions of the lode on either side of the shute. It is obvious that, as the reactions over lodes of the two classes vary, the operator, with a little experience in the neighbourhood, is able to pick out the most metalliferous lodes.

Another method of working is to earth the transmitting electrodes parallel to the expected strike of the lodes. Obviously in this case, the waves in the centre of the field also travel in a parallel direction, and if the apex of the lode is not too deep down, a "shadow" takes place in the earth at the back of the lode. A considerable portion of the work the electrical ore-finding system will be called upon to do will consist of tracing a lode being mined at one point on adjacent properties where its location is impossible, owing to the absence of surface or other indications. Operations of this class are very simple in most cases.

THE QUESTION OF DEPTH.

After showing the method of procedure in the case of faulted lodes, Mr. Williams dealt with the question of depth. The test as to depth is obtained by restricting the electric field so that audible sounds are only obtained over a given diameter, and with waves of the highest potential possible. Once ascertaining this radius, and contracting it by cutting down the prime energy used and narrowing the distance between the transmitting electrodes, the approximate depth to which the waves penetrate is easily calculated, and obviously a lode situated below that depth can show no variation in the field above. An operator, after a little experience in the various formations, and especially that in which he is working, soon learns from his sounds to estimate the depth with a degree of accuracy which is remarkable. Time being too limited to go into the questions of the varying formations and enclosing rocks, or into lodes of complicated character, Mr. Williams offered to give anyone interested in the question, especially mining engineers, any information on special points required at his laboratory at Ealing.

INSTANCES OF WORK DONE.

A few instances of work done on various mines during the period of development were given. The first experiments, made in 1899, were in Alaska, on Gravina island, where a lode outcropping, showing copper, was found between high and low tide. Lodes here bore N.E. and S.W., and as croppings of similar ore were found over a distance of 3,000 ft. in this direction every mining and geological indication pointed to this

as being the lode. Waves earthed to the lode in the tide water were persistently carried up the hillside, and in a direction different from that of the supposed strike of the lode, and diverging from the direction of the general trend of ore bodies in the neighbourhood. The waves travelled up the hill as stated, irrespective of the direction in which they were thrown out. However, in face of the geological indications, and the limited experience obtained up to the time, I did not feel warranted in doing expensive development work along the line indicated by the waves. After a considerable sum of money had been expended in other directions, it was found (as indicated by the electrical ore finder) that the croppings had nothing to do with the lode, and subsequent work proved the lode to run abnormally and up the hill where the field was so intense.

On Prince of Wales's Island a small but rich lode of galena was exposed on the beach. Many prospectors had sunk pits on the hillside in attempts to find the lode, but without success. I attached one electrode to the lead and easily traced it—it being highly conductive—to a point 190 ft. from where the pits had been sunk, and after a few days' work uncovered a lode 2 ft. wide, with good lead ore in it.

At Cwmystwyth, in North Wales, indications of a conducting shute were observed over a lode which had apparently been worked-out to that point. The fore-breasts of the lode showed no lead, and were not being worked. The level was continued, and lead found after driving about 18 ft., and at a point indicated by the waves.

At Alston Moor, Cumberland, several lodes were indicated, and accompanying variations showed the presence of lead. Only one of these has been developed, and two lodes side by side exposed.

On Cleator Moor, hematite in irregular deposits was successfully worked on.

These are some of the instances of work in Great Britain. Tests have been carried out in Western Australia within the last few months. On one mine a parallel lode was indicated, the existence of which was not even suspected by the management, and a cross-cut put in discovered a lode 25 ft. wide. On another well-known property, indications of three parallel lodes were found with marked and distinct variations. A shaft was put down on the central electrical variation, and a quartz lode found. A diamond drill bore, put in, I believe, horizontally, found the other two lodes.

Operations with the ore finder were started in the immediate neighbourhood of Smeinogorsk, and indications of mineral were found in five different places. Prospecting work soon proved the presence of copper at one of these spots, and in the opinion of Dr. Gregor Mayer, the eminent Russian geologist, and Mr. E. E. Kiss-Schlesinger, the Administrator of the Chartered Company, copper existed at three of the other spots indicated by the ore finder. The operators were, however, informed that their immediate work was not the detection of copper deposits, but to ascertain if auriferous formations existed in the district. The district was further explored by the operators, who eventually selected a spot where the ore finder recorded the existence of promising metalliferous formation, though there were no surface indications that confirmed this. Boring operations were subsequently commenced, and the drill, after passing through 30 ft. of subsoil and 50 ft. of chloritic schist, entered the formation indicated by the electrical ore finder operators. It proved to be a gold-bearing strata of considerable promise.

Details were also given of work in Siberia. The author, in conclusion, claimed that the electrical ore finding system can not only trace up lodes, but can discover and locate unknown lodes and deposits; tell the approximate depth thereof, and pick out the most metalliferous portion of the lode.

Dr. S. P. Thompson then discussed the apparatus from a scientific point of view, and described the results which he had obtained with it in Wales. He said it was a satisfaction to him that the inventors have not claimed for their apparatus that it would find every kind of ore or pick out every sort of metal. One would have instinctively put down their invention as another of those psychological apparatuses like the divining rod and other bygone toys. Describing the process as a simple and practical method, he showed how the series of short sharp impulses given by the transmitter, and transmitted through base-lines into the earth through a pair of metal rods planted in the ground found their way round to the telephone receivers connected with the second pair of exploring rods. In exploring the field with the latter, if the sound became louder, they made one inference, if it became fainter they drew another, and it was possible to indicate with considerable precision the direction of the lode. He admitted having been very sceptical when asked to go down to see the apparatus at work in Wales. However, he went to the place described by Mr. Williams, and they explored a very difficult and broken hillside. There was a deep V-shaped gully running up the hill. Both banks of this gully had been worked at different times and by different methods. On one hillside they planted this transmitting apparatus, which gave off the interrupted electric current. Lines were run out to about 130 ft. in each direction and the rods put in the ground at two different places. They wished to make sure of having a good deep contact, and therefore had a base line of 240 ft. in length. Going to a distance somewhat over a quarter of a mile across this gully, they explored backwards and forwards in places where the lode was supposed to have crossed, putting in the exploring rods and listening in this telephone to a light noise like the faint tapping of a woodpecker against a tree. They presently found one place where sound reached a minimum, and therefore came to the conclusion that they were standing above the conducting lode, the transmitting apparatus being across the other end. Professor Thompson then verified a number of points of view which occurred to him, and finally came away fully convinced that in countries where metalliferous veins such as galena or copper glance ore is to be found, this method of exploration was a very useful one. He could not say from experience whether it would be of equal use in gold mining, but it could be used for a large number of metalliferous ores when known to have good conducting properties, and also for exploring non-conducting reefs such as quartz. It was a scientific method of exploring them underground, and would be of enormous use in saving the trial holes which people put down. No hard work was involved in its use, and he ventured to believe that the apparatus was destined to perform very good service in useful fields.

Mr. Fawcus having also given an account of his experiences with the use of the apparatus, experiments were carried out in a miniature field contained in a tank, and were watched with much interest. The audience included several ladies.

NEW TYPE OF FOUR-COUPLED EXPRESS PASSENGER LOCOMOTIVE.
(Designed by Mr. George Whale for service on the London and North-Western Railway.)

FOUR-COUPLED PASSENGER LOCOMOTIVE FOR THE L. & N.W. RAILWAY.

IN order to deal effectually with the continually increasing speed and weight of the fast express passenger trains on the London and North-Western Railway, Mr. George Whale, the Chief Mechanical Engineer, has designed and is now building at the Crewe Works a new class of locomotive which will be used principally for hauling the heavy express trains running between London, Liverpool, and Manchester. Five engines of this class have been completed, and are satisfactorily doing the work for which they were designed. The engines are 4-coupled, the trailing coupled wheels being behind the firebox. The leading end of the engine is carried on a double radial truck, the centre of which is fitted with a radial axlebox and side controlling springs. This arrangement permits 1 in. side play, and allows greater freedom when passing round curves than is possible with the ordinary type of bogie fitted with a rigid centre pin. The cylinders are 19 in. in diameter, with a stroke of 26 in., and are placed between the frames, having balanced rectangular valves worked by Joy's valve gear. The coupled wheels are 6 ft. 9 in. diameter, and the truck wheels 3 ft. 9 in. The boiler-barrel is 11 ft. 9¾ in. long, and 5 ft. 2 in. diameter outside. The firebox is 7 ft. 4 in. long, with a grate area of 22·4 square feet. The working pressure is 175 lb. per square inch. Heating surface in tubes, 1,848·4 square feet; in firebox, 161·3 square feet. Total, 2,009·7 square feet.

Hitherto the tenders attached to the London and North-Western Railway Company's engines have been constructed with wooden frames after Trevithick's design, and have simply been enlarged from time to time to suit modern requirements. A new departure has now been made, the tender of the new engine being made of steel throughout. It has a water capacity of 3,000 gallons, and carries 6 tons of coal. It is carried on three pairs of wheels 3 ft. 9 in. diameter. It is fitted with the "pick-up" apparatus for taking water whilst the engine is travelling, the scoop being worked from the footplate by a hand wheel and screw.

The following are some of the principal dimensions of the engine :—

CYLINDERS.—Diameter, 19 in.; stroke of piston 26 in.; length of ports, 1 ft. 3 in.; width of steam ports, 2 in.; width of exhaust ports, 4½ in.; distance apart of cylinders, centre to centre, 1 ft. 10 in.; maximum travel of valve, 5 in.; lead of valve, $\frac{3}{16}$ in.; lap of valve, 1$\frac{1}{16}$ in.; valve gear, Joy's; diameter of piston rod, 3½ in.; length of connecting rods between centres, 7 ft.

BOILER (Steel).—Length of barrel, 11 ft. 9¾ in.; largest diameter outside, 5 ft. 2 in.; least diameter outside, 4 ft. 11½ in.; thickness of plates, ⅝ in.; thickness of smokebox tube plate (steel), ⅞ in.; working pressure, 175 lb. per square inch.

FIREBOX (Steel).—Length outside, 7 ft. 4 in.; width outside, 4 ft. 1 in.; depth below centre of boiler, 6 ft. 3 in.; thickness of plates, ⅝ in.; distance of copper stays apart, 4 in.; diameter of copper stays, 1$\frac{1}{16}$ in. and 1¼ in.

INSIDE FIREBOX (Copper).—Length at bottom (inside), 6 ft. 7⅝ in.; width at bottom (inside), 3 ft. 4¾ in.; from centre of boiler to top of firebox (front end), 1 ft. 2½ in.; from centre of boiler to top of firebox (back end), 1 ft. 1½ in.; thickness of plates, $\frac{9}{16}$ in.; thickness of tube plate (copper), 1 in.

TUBES.—Number of tubes, 309; length between tube plates, 12 ft. 2¼ in.; diameter of tubes (outside), 1⅞ in.; diameter of exhaust pipe nozzle, 5¼ in.; height of chimney from rail, 13 ft. 4½ in.; height of centre of boiler from rail, 8 ft. 5 in.

WHEELS.—Diameter of driving and coupled wheels, 6 ft. 9 in.; diameter of truck wheels, 3 ft. 9 in.; thickness of tyres on tread, 3 in.; distance between centre of truck and centre of driving wheels, 12 ft.; centre of truck wheels, 6 ft. 3 in.; centre of driving to centre of trailing wheels, 10 ft.; total wheel base of engine, 25 ft. 1½ in.; total of engine and tender, 47 ft. 2¾ in.

AXLES, TRUCK.—Diameter of bearings, 6¼ in.; length of bearings, 10 in.; diameter of axle at centre, 6 in.; distance between centres of bearings, 3 ft. 8½ in.

AXLES, DRIVING.—Diameter of bearings, 8 in.; length of bearings, 9 in.; distance between centres of bearings, 3 ft. 10 in.; diameter of bearing at centre of axle, 7¼ in.; length of bearing at centre of axle, 5½ in.; diameter of connecting rod bearing, 8 in.; length of connecting rod bearing, 5½ in.

AXLES, TRAILING.—Diameter of bearings, 7½ in.; length of bearings, 1 ft. 1½ in.; distance between centres of bearings, 3 ft. 5½ in.

FRAMES (Steel).—Distance between frames, 4 ft.; thickness of frames, 1 in.

WEIGHT OF ENGINE IN WORKING ORDER.—On truck wheels, 21 tons 15 cwt.; on driving wheels, 19 tons; on trailing wheels, 19 tons; total, 59 tons 15 cwt.

WEIGHT OF TENDER IN WORKING ORDER.—On front wheels, 12 tons; on middle wheels, 12 tons 5 cwt.; on trailing wheels, 12 tons 15 cwt.; total, 37 tons.

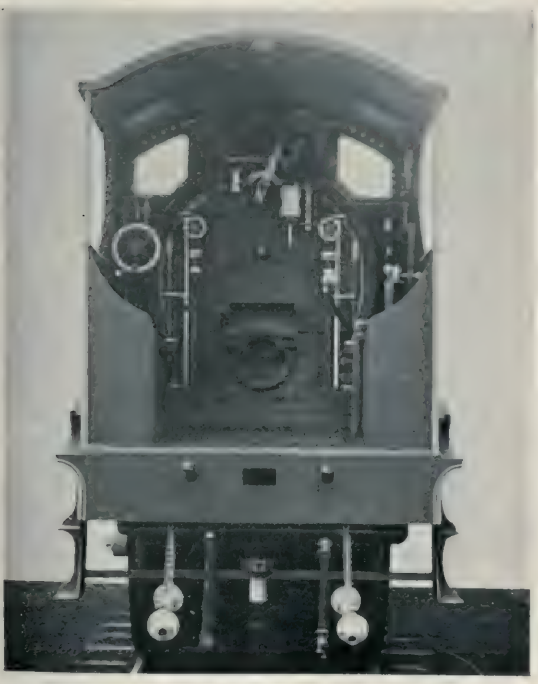
TOTAL WEIGHT OF ENGINE AND TENDER IN WORKING ORDER.—96 tons 15 cwt.

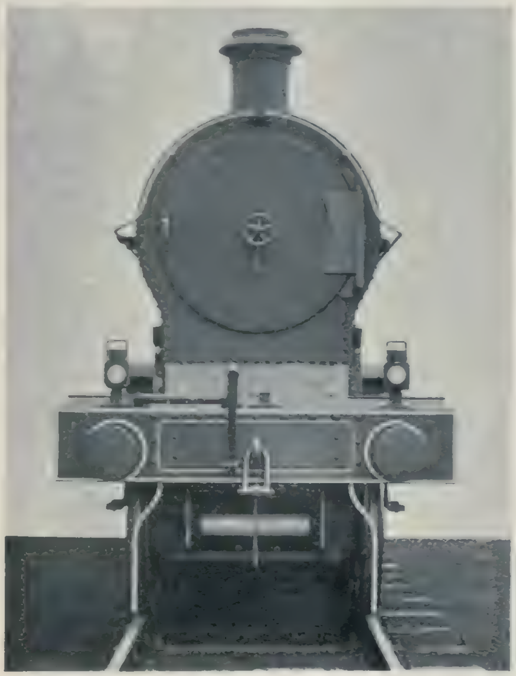
TENDER WHEEL BASE.—Centre of front wheel to middle wheel, 6 ft. 9 in.; centre of middle to trailing wheel, 6 ft. 9 in.; total wheel base, 13 ft. 6 in.

WHEELS.—Diameter of wheels on tread, 3 ft. 9 in.; thickness of tyres, 3 in.

AXLES.—Diameter of bearings, 5 in.; length of bearings, 10 in.; centre to centre of bearings, 6 ft. 6 in.; capacity of tank, 3,000 gallons; capacity for coal, 6 tons.

TOTAL LENGTH OF ENGINE AND TENDER OVER BUFFERS.—56 ft. 3½ in.





FRONT AND REAR VIEWS OF THE "PRECURSOR."

H.M.S. TRAINING SHIP, "BELLEROPHON."

INDUS I., II., AND III.

THE Admiralty shows everywhere a disposition to begin at the beginning with its *personnel.* It is realised that in order to inculcate those qualities which make our "handyman" a model for the world's navies, training and discipline must not only be thorough, but must also begin early. The latest outcome of this policy is seen in the determination of the Admiralty to enter boys and train them for the rating of engine-room artificers. H.M.S. *Bellerophon* has been fitted out for the reception of 200 boys, who, after passing through the training ship, will be drafted on to the various men-of-war, forming nucleus crews of highly trained men. In this way many repairs will be effected afloat which at present necessitate a period in dock.

A familiar sight at Devonport in future will be the three floating workshops, *Bellerophon*, *Téméraire*, and *Indus*, moored together, and known henceforth as *Indus I., II.*, and *III.*

ALTERATIONS TO THE "BELLEROPHON."

The extensive alterations to the *Bellerophon* have been carried out under Captain Haddy and his overseers (Messrs. Blatchford and Ball, by Palmer's Shipbuilding and Iron Co., Ltd., of Jarrow-on-Tyne, to whom we are indebted for the accompanying photograph of the ship.

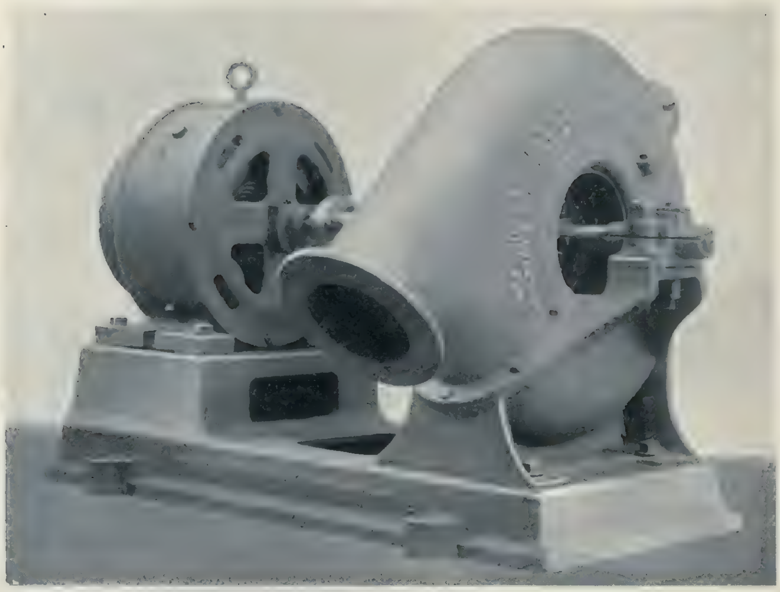
It will be seen that the huge conning tower, which was a conspicuous feature of the vessel, has given place to a roofed-in deck, forming a spacious workshop, which has been completely fitted with machine tools, chiefly by Messrs. James Archdale and Co., Ltd., of Birmingham, but also by Messrs. Armstrong, Whitworth and Co., Chas. Churchill and Co., Reed and Foggin, Robinson and Sons, and Smith and Coventry. Messrs. James Archdale and Co., Ltd., supplied no less than nineteen separate machine tools.

Messrs. Alldays and Onions have provided sixteen smith's forges and five coppersmith's forges with motor-driven fan blasts, and a large power hammer electrically driven has been erected by Peter Pilkington, Ltd., of Bamber Bridge, Preston.

A vast amount of work has been involved in fitting up and furnishing the classrooms, gymnasium, drawing office, mess room, berthing accommodation, baths, etc., necessary for so large an establishment, and we are pleased to be able to record that the whole of this work has been very smartly and efficiently carried out.

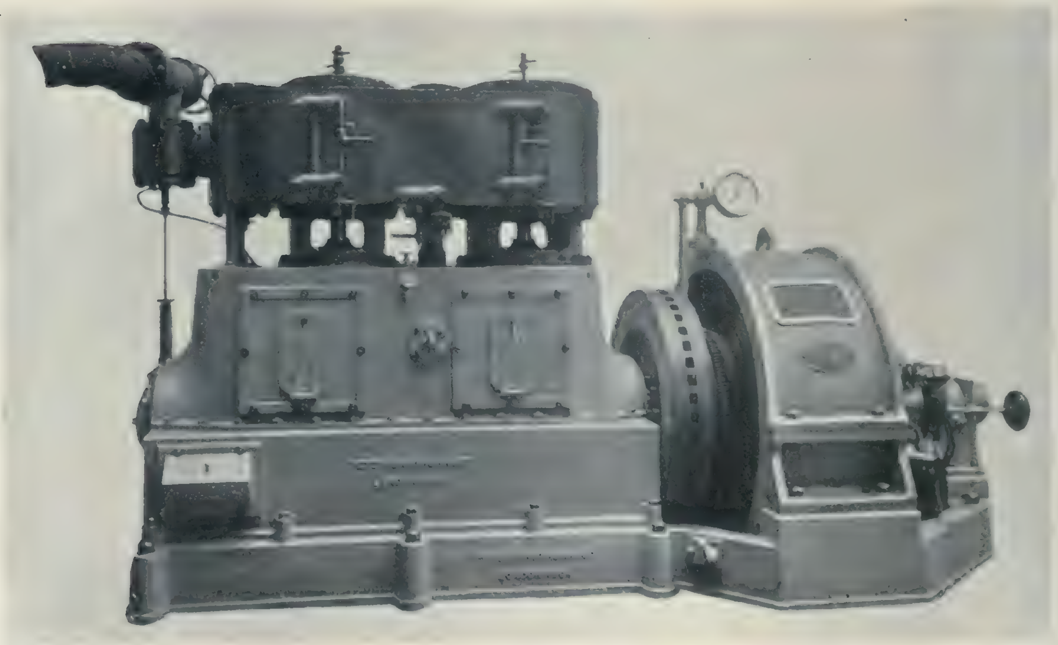
ON BOARD H.M.S. "BELLEROPHON"—THE MACHINERY DECK.

ANOTHER VIEW OF THE COVERED-IN DECK OF THE "BELLEROPHON."

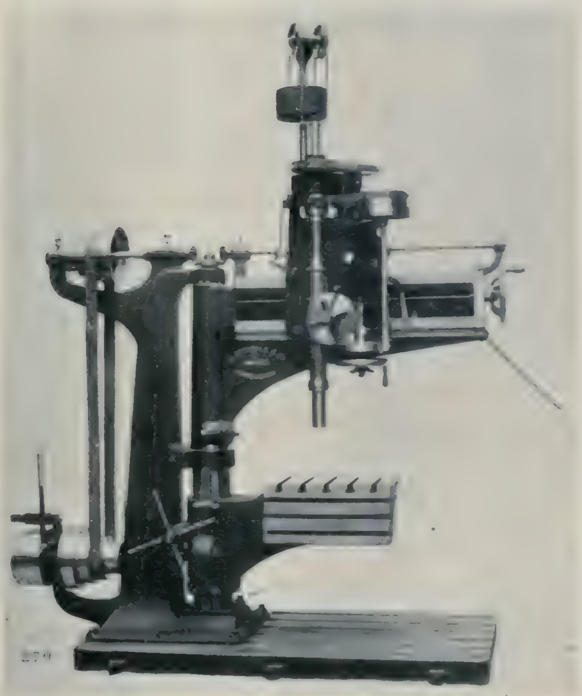


A MOTOR-DRIVEN FAN FOR THE "BELLEROPHON."
By Messrs. Alldays and Onions, of Birmingham.

Some of the Machinery employed on the "Bellerophon" and "Temeraire."



STEAM DYNAMO FOR H.M.S. 'TEMERAIRE.'
Engines by Mr. Peter Brotherhood; dynamo by the Thames Ironworks Shipbuilding and Engineering Company, Ltd.



NEW TYPE RADIAL DRILLING MACHINE.
By Messrs. James Archdale and Co., Ltd., of Birmingham.

were designed, built, and delivered at Jarrow, within eight weeks of the receipt of the order.

The power hammer, by Peter Pilkington, Ltd., has a 12 in. stroke, for dealing effectively with 3-in. bars, and is fitted with their latest controlling gear, which enables the smith to use the hammer as a vice for bending and other purposes. The hammer, as seen in the illustration below, is self-contained, this design having proved very suitable for placing aboard ship, avoiding as it does the necessity for a loose anvil block and its attendant complicated foundations. This class of hammer was first accepted by the Admiralty for H.M.S. *Assistance*, and has since been adopted by various Governments for similar purposes.

COMMUNICATION AND TRANSPORT.

A narrow platform, about 70 ft. in length, has been constructed alongside the *Téméraire*, in order to facilitate the handling of stores.

It has been arranged to connect the ships by means of two lattice girder bridges, each of about 50 ft. span.

THE "TEMERAIRE."

The *Téméraire* has also undergone very extensive alterations, including the provision of carpenters', electricians' and armourers' workshops, stores, etc. Here, also, is the generating station, which will furnish the three ships with current for both lighting and power.

The removal of the six after boilers and engines of the *Téméraire*—a work of considerable difficulty, owing to their very thorough construction—had to be undertaken, and two complete decks have been built into the spaces thus left vacant.

ELECTRIC POWER.

The two dynamos, each of 100 kilowatts capacity, on board the *Téméraire* were provided by the Thames Iron Works Shipbuilding and Engineering Company, Ltd. The engines have been specially designed for the purpose by Mr. Peter Brotherhood, and develop about 145 h.p. each, at 450 revolutions per minute.

It is worth noting that the engines

POWER HAMMER FOR H.M.S. "BELLEROPHON."
By Peter Pilkington, Ltd., of Bamber Bridge, Preston.

OUR CANALS.

CAN THEY BE RESUSCITATED?

BY

C. MACDONALD.

Attention is here called to a question which is coming more and more to the front. The writer shows what has been done in other countries in the direction of electrical haulage, and describes in detail the Thwaite-Cawley system as experimented with in the North of England. The resuscitation of our canals is a question hedged about with difficulties, but at the present time there are some indications that these are likely to be overcome.—ED.

WE have in Great Britain to-day some 3,520 miles of internal waterways. Of these 415 miles have been allowed to become obsolete, or have been converted into railways, while the canals which are in actual working order cannot be said in any degree to fulfil the functions which were contemplated by their projectors. The great boom in canals during the first half of the eighteenth century was succeeded by railway locomotion before it had time to establish a firm footing, and the steady growth of railway enterprise has been coincident with the gradual extinction of the canal.

At the present time the various systems are hampered by the claims of divided ownership. The railway companies have bought up some 1,264 miles of canal or a third of the total, and the whole tendency has been inimical to the establishment of through rates. Nor are these the only disadvantages under which our canals at present labour. An effete system of horse towage is largely employed, and there is a lack of uniformity in gauge, more especially as affecting locks and headways under bridges.

FUTURE OF ENGLISH CANALS.

Despite these disadvantages and the present moribund condition of English barge canals, we have in these internal waterways something more than a memorial to such names as Brindley and Telford, Smeaton and Rennie. When cheap transport means so much to the British manufacturer, it is impossible to suppose that so valuable an asset can be allowed to remain fallow. At the present time Sir J. Brunner is introducing a Bill into Parliament in order to enable municipalities to work disused canals, and there can be little doubt but that Government intervention will sooner or later rescue the English canal systems from their present precarious condition. It will not be out of place, therefore, to consider some of the means which have been proposed to improve the methods of haulage employed on canals, for there can be little doubt that improved administration and mechanical means will go hand in hand in any satisfactory solution of the problem.

STEAM HAULAGE.

Experiments in the improvement of canal haulage have been in progress for a number of years, and in a few cases steam haulage has been successfully applied, more particularly in the case of the Aire and Calder Navigation, where it was found practical and economical to draw a train of coal barges, each of 40 tons capacity, by means of a steam tug. The cost, as stated before the Select Committee on Canals in 1883, was 0·0087d. per ton per mile. The average cost of horse haulage works out at 0·33d. per ton per mile.*

The wash caused by the propellers is, however, in most cases an insuperable bar to the use of steam, owing to the damage done to the banks, and another difficulty is found in the weeds which are steadily choking up many of the canals. Chain and wire rope systems, as used on the Continent, have also been experimented with, but have not proved adaptable to local conditions, and to some extent oil and gas engines have also been tried.

ELECTRIC HAULAGE.

This brings us to the question of electric towage, which seems to provide the wherewithal for the future development of our canals. At any rate, it is safe to aver that if our canals are to be resuscitated, electricity will play no small part in the matter.

* For these facts and figures the author is indebted to Mr. H. Gordon Thompson's handy treatise on "The Canal System of England."

The Germans were early in this field, and as a result of careful experiments on the Teltow Canal near Berlin, it has been found that electric locomotives, as shown in the accompanying illustrations, are more efficient than electric tug boats, and require less current to do the same amount of work. In the case of the Teltow Canal the crossing difficulty is avoided owing to the fact that both sides are equipped for electric motors. The tow-rope can be shortened or lengthened from the car by means of an electrically-driven winch. Further reference to these experiments is made at the close of this article.

English engineers have not had the same amount of encouragement, but nevertheless a good deal of attention has been given to the matter, and I have before me a most interesting specification, dated 1894, of the Thwaite-Cawley System of Electric Canal Haulage. This is also illustrated in the accompanying pages by the courtesy of Mr. B. H. Thwaite.

THE THWAITE-CAWLEY SYSTEM.

Under this system metallic standards or posts of wood are erected along the side of the canal or waterway, and to these standards or posts are affixed, one above the other, at convenient heights, two metallic beams or rails of double angle or other suitable section. These beams or rails are metallically connected together, end to end, and made practically continuous along the whole length of the haulage system. The upper beam or rail is so arranged as to carry upon it an electric locomotive suitable for hauling a vessel, carriage, or other vehicle along the waterway or canal haulage track, generally in one direction, and the lower beam is similarly arranged and adapted for carrying a like locomotive for hauling in the opposite direction. In order to prevent slipping of the locomotive wheels during the time of hauling, a suitable rack is affixed to each beam or rail, into which gears an equally pitched pinion or pinions driven by an electric motor, carried on the locomotive. In some cases grip pulleys, pressed together by a suitable spring or springs, may be used instead of the rack and pinions.

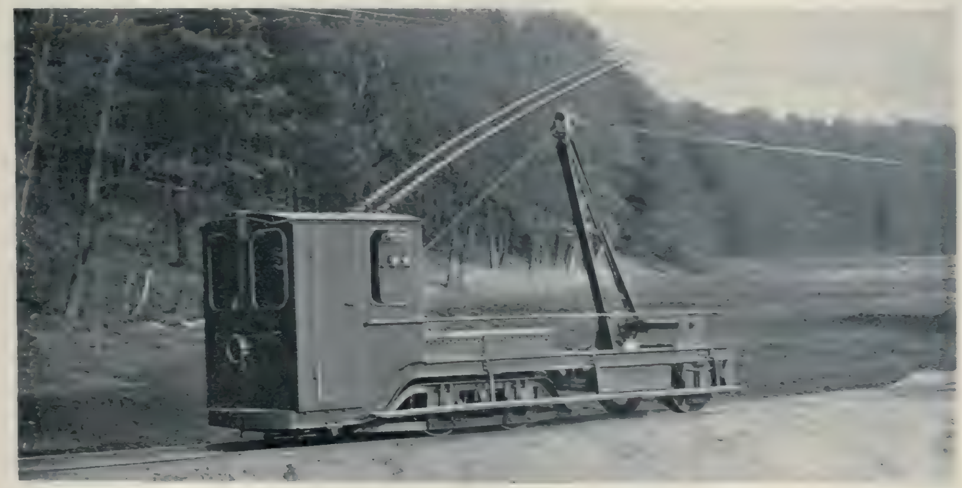
The electric energy is generated at stations, suitably distanced along the haulage route, and conveyed to supply the electric motors by suitable conductors, carried either in, upon, under, above, or alongside the beams or rails which carry the electric locomotive. The electric energy can be regulated or switched off entirely from the electric motors by a suitable switch or by a lifting contact slide, either of which can be actuated from the vessel or carriage by a rod or rope or electric connection. The electric locomotive may be connected with the vessel or carriage by a hawser or tow line fitted with one or more helical springs or other elastic connections provided for the purpose of reducing the stress on the tow-line when the speed of the vessel or carriage is being accelerated, or the tow-line may be wound round a spring-barrelled capstan fitted on the vessel or carriage or on the electric haulage motor This capstan would unwind when undue stress comes upon the tow-line, and rewind in proportion as the stress becomes normal.

SUMMARY OF ADVANTAGES.

The advantages of this system are thus summarised.

By the employment of the novel arrangement of two levels of rails, one motor can pass the other in a contrary direction without involving an entanglement of the haulage hawser or other connection.

By the use of two beams or rails placed above each other and carried on supports or standards, there is consequently very little of the ordinary towing-path appropriated by the system. This enables the system



MOTOR ON THE TELTOW CANAL,
Showing trolleys and tow-rope in position.

TOWING BY ELECTRICITY ON THE TELTOW CANAL.

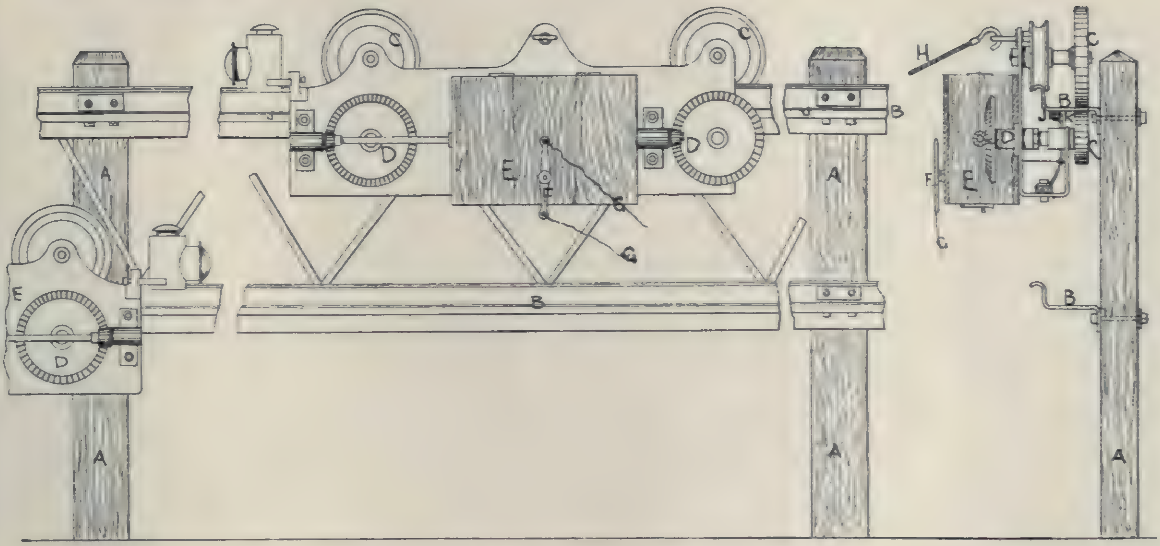


FIG. 1. FIG. 2.

THE THWAITE-CAWLEY ELECTRIC CANAL HAULAGE SYSTEM.

to be applied to any canal and towing-path without interfering with ordinary horse haulage.

The system renders it possible to imitate very nearly all the conditions of the existing horse haulage, the traction beams or rails being of such a character as to permit of its being continued along the tunnels and under bridges where the towing-path space is limited.

The novel method adopted of using a very light electric haulage motor, having a rack and pinion arrangement or a grip or pressure contact of driving, permits the invention to be used with highly economic advantages. On one hand, a heavy locomotive is avoided and its necessary disadvantages, and on the other hand are the advantages over screw propulsion in water with its high rate of loss due to slip.

Another advantage that follows the employment of the invention is the fact that, by the employment of the coil spring, capstan, or other elastic arrangement, the pull on the motor is always applied gradually, whether such strain has an accidental or intentional origin. Further, the fact that the torque effort of the electric haulage driving pinion is limited within narrow limits also prevents a seriously sudden pulling strain on the haulage rope.

The arrangement of rack or pinion or grip or pressure adhesion, either with contact surface on the vertical or underside of the rail, prevents dirt from interfering or clogging the teeth of the track gearing, or obstructing the electric current. The method by which the conductor is arranged is such as to prevent any accidental and dangerous contact to animal life, and is not affected by the weather.

Still another advantage of the system follows from the method by which the man on board the vessel or carriage can stop the motor or start it, and if necessary drop the haulage rope or hawser to the ground from its attachment to the electric haulage motor, so that full control of the system is possible from the vessel or carriage.

The provision of more than one power generating station along the route enables the loss of electric energy due to resistance to be reduced; it also has the advantage that follows the subdivision of power production, and an accident at one of the generating stations only affects the section fed by it, but in order to obviate even this fractional difficulty the conductor of each section is connected with the conductor or conductors of the next section in both directions, so that when an accident happens at one station the electric energy can be supplied from one of the other sections.

The conductor rails may occasionally be placed on each side of the canal or other waterway, and in certain instances they may be suspended by special stanchions or standards over the waterway. By this means difficult haulage problems can be satisfactorily solved.

By this method of transmitting the electric energy at high pressure and allocating this energy to short sectional lengths at a low pressure, the loss of energy over a long length of conductor is reduced very considerably.

OTHER PROPOSALS.

I understand that the system has been the subject of exhaustive experiment and has gained the unqualified approval of Sir Leader Williams, C.E., Mr. Marshall Stevens, Mr. White, of Leeds and Liverpool Canal, and the engineers of the Rochdale and Manchester, and the Sheffield and Hull Canal Companies. When introducing the subject to the British Association Mr. A. H. Allen A.I.E.E., remarked that previous attempts towards

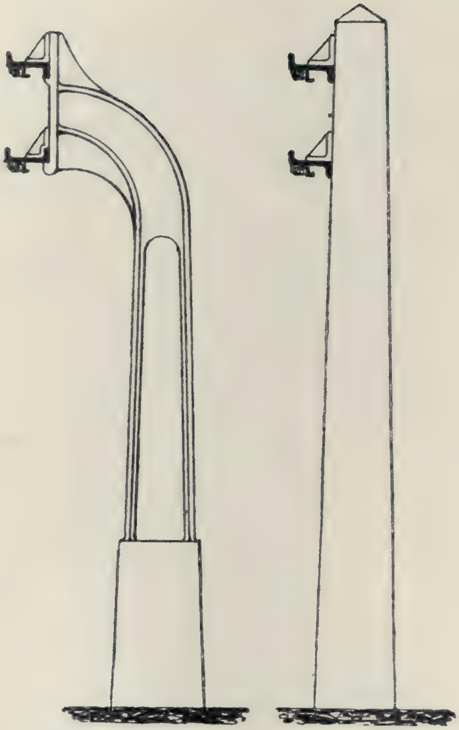


FIG. 3. THE THWAITE-CAWLEY ELEVATION OF THE POLES TO SUPPORT TRACK.

applying electric traction have generally been in the direction of supplying electrical energy by means of overhead wires along the banks, to electromotors carried on board the barges. The motors were usually geared to screw propellers (as, for instance, on the Erie Canal)—in one case to an aerial propeller. None of these methods have attained any degree of success, chiefly on account of the same difficulties as lie in the way of steam propulsion. A length of three miles on the Burgundy Canal is operated electrically by means of a chain laid along the bed of the canal. A tug boat fitted with an electromotor and chain barrel works to and fro on the chain, hauling a train of barges. The current is received from an overhead wire and returns *viâ* the chain and earth. The system is well adapted for the case in question, as two out of the three miles are through tunnels; but the great loss of time incurred when one train passes another is a fatal bar to its general adoption.

In the system under discussion all these difficulties are avoided by making the motors entirely independent of the barges and hauling the latter by means of ropes, exactly as with horses; in this way the waste of energy ncurred with a screw propeller is almost entirely obviated.

RELATIVE COST OF SYSTEM.

In order to demonstrate the economic possibilities of the system statistics were presented showing the cost of haulage, (1) by horses, (2) by electric locomotives, at the same running speed as with horses, and (3) by electric locomotives at a higher speed (four miles per hour). For the purpose of this comparison the case of a level canal, 30 miles in length, has been taken with an annual traffic of 100,000 tons per mile. The details of the estimates are briefly as follows:—

	Cost per ton-mile. d.	Time occupied in transit (hours).
Haulage with horses at 2½ miles per hour	0·077	15
Electric haulage at 2½ miles per hour	0·032	12
Electric haulage at four miles per hour	0·041	7½

Mr. Allen pointed out that, without taking advantage of the higher speed possible with electric haulage, the cost is 58·4 per cent., and the time 20 per cent., less than with horses, while when the speed is increased to four miles per hour the cost is 47 per cent., and the time 50 per cent., less than with horses. Further, in the latter case no allowance has been made for the reduction in the capital cost of barges (of which a smaller number would suffice), in the interest and depreciation on capital, and in the wages paid to bargemen, nor for the increase in the traffic and reduction of tolls, which are sure to follow the increase in speed, the sale of electrical energy, the great reduction in cost of maintenance during prolonged frosts, etc., all of which are items of the first importance in this connection.

Mr. Allen sums up the advantages of electrical haulage as follows: The boats require no alteration whatever; the delays in passing incurred with horse haulage are obviated; bridges and tunnels cause neither difficulty nor delay; no time is lost in waiting for a train of barges to be loaded, as is the case with

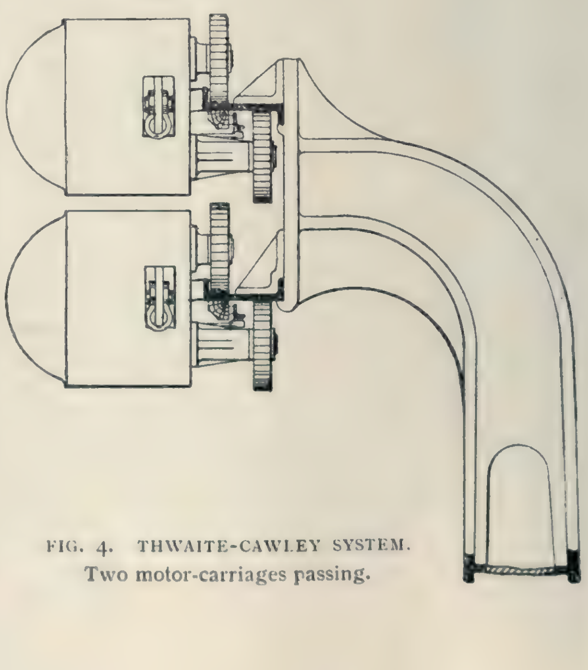


FIG. 4. THWAITE-CAWLEY SYSTEM.
Two motor-carriages passing.

steam; power can be supplied to private consumers, etc., at a low rate; the cost of haulage is reduced by 50 or 60 per cent., and the time occupied in transit by 20 to 50 per cent., as compared with horse haulage; in case of frost, the standing expenses are enormously less than with horses.

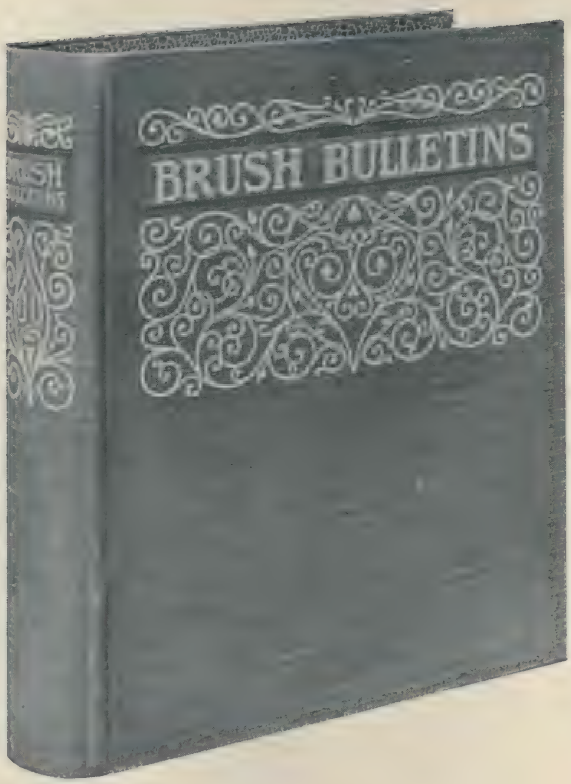
TOWING ON THE ERIE CANAL.

A system of electrical towing is being successfully employed on the Erie Canal. Single-rail lines are employed for the electric locomotives, the parallel rails being bolted upon 18-in. rolled joists carried upon steel columns. Heavy arms attached to the frame of the locomotive carry grooved wheels which are pressed against an under rail by springs. The two 24-in. grooved driving wheels running along the top rail are driven by two motors of 40 h.p. each, the current being taken by means of an ordinary trolley pole. It is estimated that four canal boats of 250 tons each can be towed at a speed of four to five miles an hour.

THE LATEST FROM GERMANY.

The results of the hauling experiments made by the Teltow Canal Building Commission have just now been made public, and are stated as follows by Dr. Gradenwitz: The locomotive used was designed by the Siemens-Schuckert-Werke; it has a front truck, both axles of which are driving axles, being driven each by an 8-h.p. main-current motor by means of a double spur-wheel gearing; there is at the back a free guiding axle. On the truck there is a hauling pole 2·5 millimetres in length rotating round a horizontal shaft, located above the driving axle, and supporting at its upper end a funnel, through which the hauling rope is slipped. The pole is moved electrically by a 1-h.p. motor, through spur wheel and worm wheel gears. The hauling rope is wound on a drum, which is likewise moved electrically by a 2½-h.p. motor by means of a worm gear. In order to avoid any excessive strains on the locomotive, this drum is not made rigid with its shaft, but connected with the same through a friction coupling, which is disengaged at a pull as high as 1,150 kilogrammes in the hauling rope. The weight of the locomotive is about 6·5 tons. As borne out by the experiments the pull resistance is about 0·85 kilogrammes per each ton of effective load, or 0·6 kilogrammes for a displacement of one ton, with a speed of 4 kilometres. The output of the locomotive is 0·0127 h.p. for each ton of effective load, or 0·010 h.p. per ton of displacement. The amount of energy derived by the locomotive from the mains is 0·014 kilowatts per ton effective load, or 0·0112 kilowatts per ton displacement. The consumption of energy is 3·5 watt hours per ton kilometre effective load, or 2·75 watt hours per ton kilometre displacement.

The figures corresponding to speeds of 4·5 kilometres and 5 kilometres respectively were also ascertained, it being shown that 4 kilometres is the most economical speed, the consumption of energy at lower speeds being only little smaller, while with higher speeds a relatively rapid increase is noted. The efficiency of the locomotive when hauling 600 to 1,100 tons o effective load is about 65 per cent.



CATALOGUE COVER . . . . DESIGNS . . .

A Bulletin Cover.

The accompanying illustration shows the substantial cover which has been sent out by the Brush Electrical Engineering Company, Ltd., to their clients in order that the bulletins issued from time to time by the firm may be filed for ready reference. It is a well-designed stiff linen cover, and is well finished, the end-papers being elaborately gilded. Brush Bulletin No. 6, which reaches us ready punched for filing, is an illustrated section devoted to the Brush-Gutmann Integrating Wattmeters for Alternating currents. It is to be feared that a very great deal of valuable catalogue matter annually goes to waste in consequence of the difficulty of finding some suitable method by which it can be made available for occasional reference. These covers not only obviate the difficulty, but form a pleasing addition to the office shelves. A simple operation suffices to attach each bulletin as it arrives, and a catalogue produced on these lines is kept up to date with a minimum of effort.

Portable Electric Drill Booklet.

The United States Metallic Packing Company, Ltd., of Soho Works, Bradford, send us a highly ornate booklet, used for a catalogue of the C. and I. Portable Electrical Drill (manufactured by Messrs. Campbell and Isherwood, of Bootle), for which they act as agents. The prevailing tints are purple and green, and very effective use has been made of gilding. A panel is left in the design for a half-tone view of the drill to be affixed subsequent to the printing of the cover. The accompanying illustration gives a very fair idea of the result attained, but the design gains much by the gilding and embossing which, of course, cannot be reproduced here. The booklet is tied with green silk, and the larger illustrations in the interior are enclosed within line borders, the type matter being printed in black and sepia.

THE ENGLISH AND AMERICAN MECHANICAL ENGINEERS.

POINTS FROM THE CHICAGO MEETING.

THE joint meeting of the American Society of Mechanical Engineers and our British Institution of Mechanical Engineers was held at Chicago at the beginning of the month, the opening meeting being attended by about 700 members, ladies and guests.

The proceedings commenced with an address of welcome by the Hon. Lawrence E. McGann, Comptroller of the City of Chicago, representing Mayor Harrison. This was responded to for the American Society by President Ambrose Swasey, and for the British Institution by Mr. J. Hartley Wicksteed.

In the portion of his remarks which referred to the joint meeting of the two societies, Mr. Swasey, after alluding to the satisfaction with which his society visited Chicago for the third time, said it was an added and exceptional pleasure to welcome Mr. Wicksteed and the Institution of Mechanical Engineers to that country and convention. They felt that they might take a just pride in holding that joint convention with the Institution—an Institution with such an honourable record, with such a great history; and when they remembered the distinguished men who had been enrolled on the membership of the Institution—such men as Stevenson, Siemens, Whitworth, Armstrong, and he might mention scores of others down to the present time, truly they might feel a pride in joining in this convention with them. "As one of the members who enjoyed the warm welcome and the unbounded hospitality extended to the American engineers during their visits to England in 1899 and 1900, he was glad to have the privilege of reciprocating to some extent their kindness and attention. He thanked the members of the Institution of Mechanical Engineers for coming there, for it not only brought them closer together as engineers, but closer together as citizens of the two great English-speaking nations.

MR. WICKSTEED'S IMPRESSIONS OF CHICAGO.

Mr. Wicksteed joined with Mr. Swasey in thanking Mr. McGann for the extremely kind and interesting way in which he had welcomed them to Chicago. It was a great privilege to come there and to feel like cousins, and also, of course, a very great delight to come to a country which spoke the English language. It was through the kindness of the American Society of Mechanical Engineers that they, the English Institution, were able to partake of their hospitality.

More than 300 desired to come, and sent in their names, but as many of them were men too much immersed in business to leave their work for two months, it could hardly be expected as many would come from England for two months as they had coming from different parts of that country for two weeks. However, he felt sure that all those who had come felt that it was the best resolve they ever made in their lives to leave their business behind them and come over to that exhilarating country.

Chicago seemed to him to be the place of all others to which an engineer should come. Chicago was only the age of any of them. It came within the allotted span of life. In seventy years Chicago had sprung up from nothing. No doubt a great deal of the prosperity and increase of the city must arise from natural causes, from force of circumstances, from its position on that vast inland sea; but without the engineer it would not have been possible to make Chicago 14 ft. higher than the lake, as Mr. McGann said had been done. The maximum of progress was to be found in perfection, he thought, in that city.

THE CHICAGO TUNNEL SYSTEM.

He had seen that day what all men in their party ought to make a point of seeing, and that was a system of underground tunnels, in which were conveyed cables of telephone wires, but also in which were going to be conveyed cars for the transport of goods throughout the city. Coal could be transported and ashes could be taken away. Goods could be transported from one part of the city to another. There was already twenty miles of this tunnel system. It was the pluckiest thing he had ever seen, and it was really a most wonderful idea—one which he did not think was conceived of as a whole by the first promoters. But it was going to turn out one of the cleverest things, he thought, that had ever been introduced in a city. Besides this they saw, and he thought it was in connection with the same enterprise, an automatic exchange for

telephone messages, so that if the subscriber put his instrument to the right notch he could connect himself direct with any of the addresses which the telephone would reach without the aid of an operator at the exchange to switch him on to the wire he wished to get. It mechanically informed the subscriber whether the wire was busy, and, he believed, it informed him when it was free.

The impression that must be made on their minds when they saw this wonderful city, that has sprung up in seventy years, was that the mechanical expert must have played a secondary part in Chicago; that there must have been all the way through men and women with big hearts, big brains and great pluck. Considering the limitations that had been imposed on the builders of the city, it was the more marvellous that so much had been accomplished. The well-known independence of the American character, he supposed, rose superior to these restrictions, and by individual energy, enterprise and pluck, he supposed, they would somehow do what could only be done by the combined action of a community and corporation. In conclusion he cordially thanked Mr. McGann for the welcome he had given them, and the American Society of Mechanical Engineers for having invited them to come over.

The following are selected abstracts from some of the papers read :—

EXPERIMENTS WITH A LATHE-TOOL DYNAMOMETER.

An important paper was presented by Mr. J. T. Nicolson, D.Sc., Professor of Mechanical Engineering at the Municipal School of Technology, Manchester, recording the results of over 300 serial trials, each requiring the making, recording and reducing of from 50 to 100 observations. Yet it is only looked upon as a first instalment of the work required to be done in order that the action of the tools used in a machine shop may be thoroughly understood. The author, in introducing his subject, says that in the tool-steel trials made by the Manchester Committee in 1902–03 (the report upon which was published by the Manchester Association of Engineers in their Transactions for 1903), there appeared an entire lack of uniformity in the shapes and angles of the tools submitted by the eight competing firms. There was also no obvious connection between the shapes and angles of the tools and the cutting forces upon these tools deduced in the report from the electrical power measurements made by the Committee. Neither did the shape or angle supply a clue to the causes of success and failure in the various trials with different tools.

On the other hand, the necessary reconsideration of the design of lathes for the rapid and heavy cutting rendered possible by the new steels introduced by Taylor and White, and now everywhere adopted, calls for a thorough and systematic investigation of the forces acting upon a cutting tool. If a standard area of cut can be agreed upon for the various sizes of lathe, a knowledge of the forces to be overcome when taking that cut—not only for turning the work against the tool, but also for moving the slide-rest and saddle in both the traversing and surfacing directions—will enable the calculation of the stresses in, and the proportioning of, the various parts of the machine to be gone about in a rational and scientific way.

No such knowledge has hitherto been available; and it appeared to the author that the prosecution of a somewhat extensive research into the matter would well repay the time, labour, and expense which it would necessarily involve.

The thanks of the author, and, if the results obtained prove of value, those of the engineering public, should be given to those whose action alone rendered possible the carrying out of the work. First, viz., to the authorities of the Manchester Municipal School of Technology, who authorised the expenditure incurred for power, light, and mechanical assistance, to a not inconsiderable amount. Second, to the firm of Sir W. G. Armstrong, Whitworth and Co., for the continuance of their loan of the lathe used in the experiments by the Manchester Committee; for the donation of the remainder of the material unoperated upon in those experiments, viz., three steel forgings and three iron castings; and for the gift of large quantities of their AW steel of various sections.

DESTRUCTOR WORK.

Among other papers may be mentioned "Refuse Destruction by Burning and the Utilisation of Heat Generated," by Mr. C. Newton Russell, Borough Electrical Engineer of Shoreditch. A paper on the "Burning of Town Refuse, with special reference to the Destructors at Brussels, West Hartlepool, Moss Side, and Westminster," was also contributed by Mr. George Watson.

ON THE USE OF SUPERHEATED STEAM AND OF REHEATERS IN COMPOUND ENGINES OF LARGE SIZE.

The object of this paper by Mr. Lionel S. Marks, of Cambridge, Mass., was to collect and present to the Society the results of a number of unpublished tests made during the past five years on several high-speed, two-cylinder compound engines, all built by the same makers, and all of the same type. The engines tested differed from one another only in size, in cylinder proportions, and in their working conditions. The investigations were made to determine the performance of the engines under different loads, both with and without jacketing and reheating.

In summing up the general results of the tests the following conclusions appear to the writer to be justified when applied to large size, high-speed, compound, four-valve engines of common proportions.

The jacketing of the high-pressure cylinder is of but little value when moderately superheated steam (100 deg. F.) is used.

Reheating is probably a source of loss unless it superheats the receiver steam at least 30 deg. F., and is not fully effective unless it superheats about 100 deg. F. In the latter case it may be expected to

effect a saving of 6 to 8 per cent. of the total heat used per indicated horse-power.

Jacketing the low-pressure cylinder is shown by the steam qualities during expansion in the low-pressure cylinder to be unnecessary and therefore undesirable when the reheating is effective. The effect of admitting moderately superheated steam to both the high-pressure and low-pressure cylinders is to keep the heat consumption per indicated horse-power practically constant throughout a considerable range of loads—from half load to about one-quarter overload.

The variation within the ordinary limits of the ratio of stroke to diameter in large size engines of the same power when using moderately superheated steam, does not have any marked effect upon the economy of the engine. The size of the engine is an important factor in determining its efficiency.

THE STATE AS A FLY-WHEEL FOR THE ENERGY OF PRODUCTION.

In the course of a paper on "A Rational Basis for Wages," Mr. Harrington Emerson, of New York, remarks that in buying coal the wise purchaser is advised to buy by the ton, to base his price on quality and to use efficiently. He should act similarly when he buys labour. It is a reflection on the intelligence of the State that when so much is done to correct nature, to dredge harbours, build sea walls, impound waters, regulate rivers, fight against diseases; when so much more is meddled with that might be better left alone, absolutely no use is made of the great power of the State to act as a fly-wheel for the energy of production. Here at least is something in which the interests of employers and employees are one. When labour is scarce and materials high, Governments, national, state and municipal, should carefully abstain from undertaking great works of creation or improvement, but when labour is plentiful and materials low in price, Governments should carry out plans held in reserve for just such conditions. There is no other means at once so powerful and economical to minimise the ups and downs of both labour and capital.

POWER PLANT OF TALL OFFICE BUILDINGS.

Some instructive details on this subject were included in a paper by Mr. Reginald Pelham Bolton, of New York.

With regard to the height of these buildings, he remarks that secured by nature from doubt as to the permanency of their support, the limitations of height become only those imposed by practical considerations above ground, and the present practice has settled down to a general adoption of a height affording space for 16 to 20 stories, the extreme presented by the Park Row (27) and the St. Paul (25) not having justified a general imitation. In point of fact, the limitation of height has come about in a natural manner by realisation of the disadvantages of the remoteness of such lofty floors from the street, and the excessive expense of maintaining a suitable elevator travel schedule on such long runs, the burden of which excess is to be charged to the upper floors, and the returns from which are often insufficient to make the expense commercially successful. Increasing the floor area of the cars, and the speeds of the machines are subject to practical limitations, mere increase of area of cars being the cause of delay in handling the passengers, and the speed of travel being practically limited to 600 ft. per minute for stopping or way cars, and to 750 ft. for express cars, beyond which speeds more time is lost than gained by overrunning the landings.

The lighting of these buildings is universally electrical and is, as regards distribution and generation, a simple operation. Much of the interior of some buildings requires artificial lighting. Direct-current systems are employed, the feeders being made three-wire, only in order to provide for eventual possible connection of the public service; from the distribution centres on each floor the circuits are carried in two-wire work to the outlets.

The usual practice is to adopt a pressure of 120–125 volts, but in the Dun building (15), and in a few others, a pressure of 220–240 volts is maintained, operating elevator and other motors in parallel with lighting work. The reduction in size of conductors is not material, but there is a gain in simplicity of service and of connections.

The generators are in duplicate or more generally from 75 to 150 kilowatts capacity operated in parallel. Consideration of head room sometimes induced the adoption of small units, and the same factor has prevented the adoption of the vertical engine as a motive machine. The compound engine has not made much headway, more for similar reasons of space, than of disregard of its economy. The 4-valve engine is a type well adapted to the conditions, and has found some favour recently. The direct connection of engine and generator is the common form, and has much advantage in absence of noise and vibration.

The water-tube boiler of one or other of the well-known firms is in general use in these buildings.

The author remarks, with regret that the architectural profession as a body have failed to realise their responsibility in regard to the employment of proper engineering skill upon the work of the design and proportion of the power plant of these large buildings.

CAST-IRON STRENGTH, COMPOSITION, SPECIFICATIONS.

The data which is comprised in this investigation by Mr. W. J. Keep, of Detroit, Mich., consists of nineteen series of tests made for the committee on tests of the American Society of Mechanical Engineers in 1894–95, and of twelve series made in 1899–1901 by the committee on tests of the American Foundrymen's Association.

The author summarises his conclusions as follows :—

A variation of size of a casting causes a great variation in strength, because of the change in the rate of cooling.

A variation of shape of castings which have the same area of cross section causes a great variation in strength.

TABLE I.

POTENTIAL EFFICIENCY OF WATER-WHEELS

NAME OF WHEEL.	Head in Feet. H	Cubic Feet of Water per sec. Q.	R. P. M.	POWER. Available P. H. P.	Developed B. H. P.	Potential Efficiency in per cent. P.
Tremont..........	12.903	138.19	51.06	202.2	160.5	79.4
Boott	13.33	112.56	40.07	170.2	135.6	79.8
Boyden..........	16.6	147.1	63.5	277.0	222.04	80.2
Collins	16.59	113 46	63.38	213.1	131.49	85.1
Haenel..........	5.12	45.66	33.0	26.48	18.08	68.3
Tangential........	570.84	6.84	210.	440.9	336.8	76.4
Swain	12.17	162.54	69.1	227.7	190.2	83.6
Hercules..........	16.96	88.33	140.62	169.7	145.72	85.8
Victor	11.65	45.86	144.5	60.52	52.54	86.8
Faesch & Picard........	135.113	447.8	250.	6864	5335. Electric	77.85
					5500. Brake	80.26
					611.	77.0
Pelton............	658.	10.63	450.	793.	643.	81.0
					982.	83.1
Pelton.....	1919.	5.444	430.	1186.	1023.	86.2
Cascade.....	164 2	0.887	331.2	16.5	15.05	91 0
Centrifugal Pump.	425.	2.47	890.	157.	118.9	76.0

It is very difficult to calculate the strength of one form or size of test bar from the measured strength of another size.

A test bar should be cast horizontally in the ordinary way and in ordinary sand the same as other castings.

The average strength of at least two test bars cast together should be taken.

The distribution of metal in a square test bar gives a stronger casting than in a round bar of the same area of cross section, and more nearly represents the ordinary shape of castings.

A test bar 1 in. square is the size and shape in general use.

We think of transverse or tensile strength as so much per square inch.

THE POTENTIAL EFFICIENCY OF PRIME MOVERS.

The paper by Mr. C. V. Kerr, of New York, on the above subject dealt with (1) Water Wheels; (2) Steam Engines; (3) Steam Turbines.

The efficiency of a water wheel is easily expressed and easily comprehended. If the height of fall is H feet, and the flow in cubic feet per second is Q, the energy per second is $62{\cdot}3\ QH$; and if B is the brake horse-power developed, the work done per second is $550\ B$ foot pounds. Then the potential efficiency is—

$$P = \frac{550\ B}{62{\cdot}3\ QH} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In Table I. are given the results of a number of tests on water wheels and the efficiencies are expressed in the usual way. Data for most of the wheels were obtained from Professor Wood's "Theory of Turbines," and some of the tests were made at the Holyoke testing flume. The data for the Pelton wheels were furnished by Mr. Henry, chief engineer for the Pelton Water Wheel Company. The Cascade Wheel is a form of impulse wheel tested under the direction of Professor Hitchcock, of the Ohio State University.

The results show the usefulness of the guide and vane type of wheel for low heads and the remarkable efficiency of the nozzle and bucket type under high heads. The test on the centrifugal pump is added to indicate the growing effectiveness of modern high-lift pumps.

TABLE II.

POTENTIAL EFFICIENCY OF STEAM-ENGINES.

TYPE.	STEAM. Gauge Pressure.	Temperature of Saturated Steam.	Superheat at Engine.	Vacuum Inches of Mercury.	Steam per I. H. P. Hour.	Available Heat.	Potential Efficiency.	NOTES.
	Lbs.	*F.*	*F.*		*Lbs.*	*B. T. U.*	*P. C.*	
Double Vertical Single Acting........	100	338	0	0	26.19	147.8	65.8	20 × 16 Westinghouse Standard, 257 I. H. P. Shop test.
Vertical Single Acting Compound..	120	350	0	0	21.9	159.6	72.8	14 & 24 × 14 Westinghouse Compound, 170 I. H. P. Shop test.
				25	18.1	265.5	53.0	
Vertical Double Acting Compound ...	150	366	0	0	20.0	173.2	73.5	17 & 24 × 24 Westinghouse Compound. Rated 600 I. H. P. Shaft governor. Shop test.
Vertical Three Cylinder Compound.	184.6	381.5	0	25.19	12.24	285.9	72.5	43 5 & 2 – 73.5 × 60 Cylinders I. H. P. 5,310. Economic rating 4,900–5,500 I. H. P. New York Edison-Waterside.
	185.6	382.0	0	27.25	11.93	315.3	67.6	
Horizontal Double Single Acting....	126	353	288	0	17.7	211.3	68.0	Trials "A" and "C," by Prof. Ewing, at Sheffield, England. Schmidt System.
	110	344	0	0	29.7	168.1	51.0	
Single Acting Tandem Compound..	158	360	219	26.14	11.75	361.0	60.0	Trial by Prof. Ewing, at Knocklong, Ireland. 65 I. H. P.
Double Acting Compound.	140	360	0	27.5	17.2	313.6	47.0	Trial by Prof. Ewing, at Middlepolder, Am. 125 184 I. H. P.
			197	27	10.4	344.1	71.0	
Single Acting Twin Tandem Comp'd.	157.3	369	295	26.87	8.97	370.1	76.7	Trial by Prof. Lewicki on Thale Engine. 257.6 I. H. P.
Double Acting Twin Tandem Comp'd.	140	360	331	25.4	8.96	352.9	80.5	Official Trial. 1,045 I H. P. Schmidt Engine, Pabianice, Poland.
Four Cyl'der Triple Expansion Sulzer Engine...........	184	381	0	26.25	11.57	305.7	72.0	3,000 I. H. P. Rated. See *Eng. News*, Oct. 2, 1902.
	188	382.7	228	28	8.97	392.1	72.3	
Horizontal Tandem Compound.......	132.2	356.6	0	27.9	12.06	315.7	67.0	Van den Kerchove Engine. Tested by Prof. Schröter. 220 I. H. P.
	128.9	354.8	98	27.8	11.00	330.6	70.0	
	131.6	356.2	310	27.8	8.86	384.7	74.7	
Vertical Triple Expansion Pumping Engine, 780 I H.P.	155	[illegible]	0	26	11.88	279.0	80.2	20 M. Gal. Snow Pump. Test by Prof. Goss, at Indianapolis Water-Works.
Cross Compound Corliss...........	145.1	363.2	0	25.24	13.81	279.2	65.8	Rice & Sargent Engine. Tested by Prof. Jacobus, at Millbourne Mills. Phila.
	142.4	361.8	374.5	26.79	9.56	387.1	68.8	
Cross Compound Corliss...........	151.3	366.2	0	28.63	12.1	338.0	62.2	Rice & Sargent Engine. Tested by Prof. Jacobus for Amer. Sugar Ref. Co., Brooklyn.

TABLE III.

POTENTIAL EFFICIENCY OF STEAM TURBINES

Type.	Steam. Gauge Pres.	Steam. Temp. Sat.	Steam. Super-heat at Turbine	Vacuum Inches of Mercury.	Water per H. P. Hour. Indicated.	Water per H. P. Hour. * Brake.	Water per H. P. Hour. * Electrical.	Available Heat.	Potential Efficiency.	Notes. Gen. Eff = 95% Mech. Eff. = 90%.
	lbs	*F.*	*F.*		*lbs.*	*lbs.*	*lbs*	*B. T. U*	*P. C.*	
De La val	206.2	390	0	26.6	13.26	14.73	15.5	318.0	60.4	Tests by Dean & Main on 200 K. W. Unit. Full Load.
	208.3	391	81	27.2	12.2	13.55	14.3	341.4	61.2	
Westinghouse 200 K. W. Unit.	150	366	0	27	12.92		15.2	306.9	64.2	Full Load. Shop Test.
Westinghouse 400 K. W. Unit.	153	367	0	28	12.27	13.63	.....	325.0	63.9	Tests by Dean & Main. Full Load.
	151	366	182	[illegible]	10.13	11.25	.....	360.3	69.7	
Westinghouse 1,000 K. W. Unit.	149	365	0	28	12.6	.....	14.73	312.0	64.7	Full Load. Shop Test.
	136	358	[illegible]	28	11.2	.....	13.1	321.0	70.6	
	154	368	140	28	10.8	.....	12.66	341.0	69.2	
Westinghouse 1,250 K. W. Unit.	147.1	[illegible]	0	27.11	12.4	.....	14.52	304.1	67.5	Tests 6 & 11. Full Load. A. M Mattice, Power, March, '04.
	146.0	363.8	78.25	[illegible]	11.25	.....	13.17	340.3	66.5	
Westinghouse 1,500 K. W. Unit.	148	364.8	0	[illegible]	12.65	.....	14.8	301.7	66.8	Full Load. Shop Test.
	146	[illegible]	28	27.5	11.68	.....	13.67	317.0	68.8	
Brown-Boveri Turbo-Alternator. 2,600 K. W. Unit.	173	376	196	27.75	9.84	.....	11.5	372.8	69.4 (+)	Frankfort Corporation. Test at Full Load Exciter (+), or (–)
					9.5	.....	11.1		71.8 (–)	
Rateau Multicellular.	136.7	359	0	26.7	13.42	.....	15.7	293.4	64.7	525 E. H. P. Full Load. A. Rateau Eng. Mag., Oct., '03
Curtis 600 K. W..	140	360.7	0	28.5	12.2	.....	14.25	332.9	63.7	Full Load W. L. R. Emmet St. R. Rev 4-20-03.
			150		10.68	.....	12.5	365.4	65.3	
Curtis 2,000 K. W.	156.0	368.6	212	28.5	9.76	.....	11.42	[illegible]	67.0	Eng'rs Club, Phila. 3-19-04.

* Results of tests.

The data used in Table II. were obtained from engine-builders' catalogues, reports of tests published in engineering journals or directly from the parties concerned. In some instances where barometer as well as vacuum readings were not given, some injustice one way or the other may be done in comparing efficiencies.

From Table II. it will be seen (1) that simple engines with a relatively high-water rate may stand well when compared on the basis of the proportion of available heat converted into work; (2) that engines built to use superheated steam increase in potential efficiency with the amount of superheat.

The steam turbine, nominally older than the Christian era, has in the last score of years taken on a very rapid growth. The present size of units being built is a matter of common knowledge. The results of careful tests on sizes already in service are given in Table III. For the purpose of comparison with the performance of steam engines, the efficiency is based on the corresponding indicated horse-power. The mechanical efficiency is taken at 0·90 and the generator efficiency at 0·95, which combines at 85·5 per cent. This is not high enough for large vertical units, but probably quite correct for a general comparison.

TURBINE GENERATORS.

Papers specially dealing with the De Laval, Rateau, and Curtis turbines were presented. The following extract is from a voluminous paper by Mr. Francis Hodgkinson on "Some Theoretical and Practical Considerations in Steam Turbine Work":—

It is an interesting fact that, owing to the introduction of steam turbines, the general characteristics of generating apparatus have been modified to a wide extent, and in points of running speeds have returned to the practice of the first builders of electrical machinery. Owing to the restrictions placed upon the designers by reciprocating engine speeds, the dimensions and bulk of engine type generating machinery have of late years become enormously increased; similarly, the cost of construction. With the advent of the turbine, however, speeds have been increased to such a point as to secure in the generator construction minimum bulk and cost consistent with strength and durability.*

The turbine generator is more easily applied to alternating current work, for the reason that commutation difficulties involved in direct-current machinery running at high speeds are avoided. The preferable construction, therefore, comprises rotating field and stationary armature. In the present turbine generators the armature construction is not essentially different from that of the ordinary engine type machines. In the construction of the field, however, the centrifugal stresses necessitate a construction of greater inherent strength. Recent practice embraces two designs—one of built up form—used in fields having six or more poles, and the other of a solid steel casting thoroughly annealed, bored for the reception of the shaft, and slotted axially for the reception of bar or strap windings which are insulated and confined in position by wedges.

The turbine, however, makes possible the use of a still further type of generator, which, although presenting difficulties in design at ordinary engine speeds, becomes ideally suited for direct connection to the turbine, both by reason of its electrical characteristics and its inherent strength of mechanical construction.

It is well known that, if the ordinary squirrel cage induction motor runs below synchronism with the system upon which it is operated, it will absorb power from that system proportionate to the slip or drop in speed. If it is run in synchronism therewith by

*A pertinent comparison may be made in the two types of 5,000-kilowatts generators which will form the power equipment of the Rapid Transit Subway in New York City. The engine type generators run at 75 revolutions per minute, are approximately 40 ft. in diameter, and weigh 980,000 lb. The turbine generators, on the other hand, run at 750 revolutions per minute, are 12 ft. 6 in. in diameter, and weigh 234,000 lb., the weight of journals and shaft excluded in each case. The engine type generators have 40 poles, and the turbo-generators four, giving the same frequency—25 cycles per second.

external means, it will absorb no power; and if run above synchronism, it will become a generator and return electric power to the system.

When running below synchronism, the greater part of the current absorbed by the motor appears as power, but a small part is consumed within the motor itself in magnetising its rotating field. When run above synchronism, the motor, now a generator, still requires magnetising current from the line to which it is connected. It is, therefore, incapable of operating by itself, and must be run in connection with synchronous machinery capable of supplying its magnetising current and controlling the frequency of the system.

The induction or non-synchronous generator, unfortunately, imposes a lagging current upon the supply system, but the power factor can be brought within a few per cent. of unity, so that the effect upon the system may be readily neutralised. Its peculiar electrical characteristics impose limitations upon its general use for power station work, but when employed in conjunction with synchronous apparatus, such as ordinary alternators, synchronous motors and rotary converters, it becomes peculiarly suitable for extension to a power system in which the limit of generator capacity has already been reached. With the apparatus mentioned, particularly with synchronous motors and rotary converters, a sufficient leading current may be impressed upon the system by over-exciting the fields of these machines to entirely neutralise the effects of the magnetising currents required by the induction generator, so that, in general, if existing apparatus is ample to care for existing inductive loads with reasonable margin, the induction generator can be employed to great advantage.

A feature which is particularly favourable in rendering it suitable for turbine driving is, that by largely reducing the number of poles the magnetising currents may be largely reduced. For this reason the limitations of the induction generator occur largely in the direction of bulk rather than otherwise. As it must operate at the comparatively high speed of the turbine it is thus possible to reduce the number of poles to a few pairs, so that the losses above mentioned are minimised, and the generator becomes commercially practicable. And as the squirrel cage construction of the rotor is peculiarly well suited for high-speed work, we are fortunate in having here one of the few cases in which the electrical and mechanical conditions governing generator and prime mover are almost exactly suited to each other. In general, the higher the speed at which the machines can be safely operated, the less the material necessary and the smaller the losses, resulting in an extraordinary high efficiency and power factor.

For example, with a two-pole 60-cycle induction generator of 500 kilowatts, running at 3,600 revolutions, the power factor may be brought as high as 98 per cent. or higher at full load, and the total efficiency will be far greater than that of present generating machinery.

Appendix IV. to Sixth Report of the Alloys Research Committee.

THE EFFECTS OF STRAIN AND OF ANNEALING IN ALUMINIUM, ANTIMONY, BISMUTH, CADMIUM, COPPER, LEAD, SILVER, TIN, AND ZINC.

Dr. William Campbell, in his summary of the above, remarks that additional evidence is given that when a metal reaches its freezing point it begins to crystallise out from a number of points or centres. Dendrites grow from these centres and continue to grow until they meet others, when their growth is obstructed. The more rapidly a metal cools past its freezing point, the more numerous will be the centres of crystallisation, and therefore the smaller will be the structure. The dendrites continue to grow until the whole mass becomes solid in the form of irregularly bounded crystals or grains whose orientation varies from grain to grain. In the case of impure metals the dendrites which first crystallise out are usually purer than the mother-liquor, which freezes at a lower temperature. As a rule equilibrium is not established, and so the dendrites vary in composition from centre to outside, hence their structure is revealed when a section is etched. Again, as a rule, the metal contracts during solidification, and so the mother-liquor sinks beneath the surface, leaving the dendrites standing out in slight relief. These primary grains or crystals are built up of smaller or secondary grains which are revealed in etching. They may be compared with the crystals of calcite in a crystalline limestone which break up into small rhombs due to their rhombohedral cleavage, or with the crystals in massive galena which break up into cubes because of their cubic cleavage.

The effect of strain is to produce a parallel slipping along definite directions, usually related to the orientation of the primary crystals, and also to the direction of strain. In some cases the effect is seen in the formation of one or more systems of parallel slip-lines, in others in the production of systems of parallel twinning. As Ewing and Rosenhain have pointed out, the first slip-lines are perpendicular to the direction of straining, whereas further straining produces other systems. When the strain has been severe, as, for instance, by rolling or hammering, the large primary crystals are broken down and a finer crystallisation takes their place; the greater the mechanical work upon the metal, the finer the resulting crystallisation.

Annealing causes the fine crystallisation to re-arrange itself, and produces the growth of crystals, whose size apparently depends to some extent both on the time and temperature of annealing and the thickness of the metal. In the case of lead and tin this arrangement was noticed to take place at ordinary temperatures, but of course very slowly indeed.

A REMARKABLE LOCOMOTIVE TESTING PLANT.

In the course of a fully illustrated paper on Locomotive Testing Plants, Mr. W. F. M. Goss, of La Fayette, Ind., contributed some interesting particulars of the plant of the Pennsylvania Railroad System at St. Louis, Mo. The Pennsylvania Railroad System

has this year installed, as a portion of its exhibit in the Department of Transportation at the Louisiana Purchase Exposition at St. Louis, a locomotive testing plant, which is being operated during the seven months of the Exposition. At the close of the Exposition the plant will be permanently located at the Altoona shops of the Pennsylvania Company.

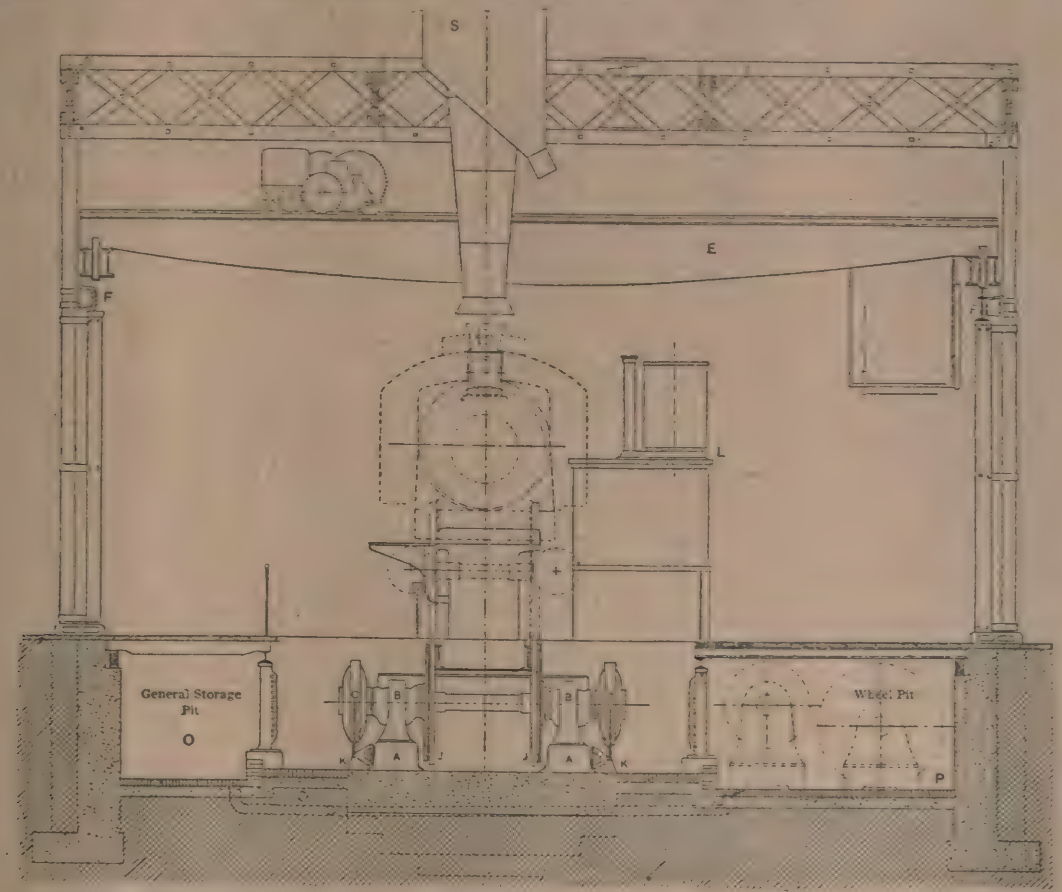
The general arrangement of the plant is shown below. The principles underlying its design are the same as those which have controlled in the development of previous plants; but it is gratifying as it is logical that this latest development of the testing-plant idea is of greater capacity and far more perfect in its details than any which have preceded it.

A continuous concrete foundation carries the two longitudinal bed-plates, *A*, and extends under and forms a part of the pier supporting the traction dynamometer. The bed-plates are provided with longitudinal T-slots, by means of which pedestals carrying the axles of the supporting wheels are mounted. Two sets of supporting wheels are supplied, one consisting of three pairs, 72 in. in diameter, for use under passenger locomotives; and the other set of five pairs, 50 in. in diameter, for use under freight locomotives. Each supporting axle has its own pedestal and journal boxes. The supporting wheels resemble in form, the usual locomotive driving wheels, having cast-steel centres with tyres held by shrinkage and by retaining rings. The contour of the tyre is such as to provide a tread similar in form with that presented by the head of a rail; outside of which and separated from it by a wide groove is a light flange designed to keep the tread free from oil which may drip from the locomotive while running.

The equipment includes eight Alden brakes, any of which may be used upon any of the supporting axles, the arrangement being such that one or two brakes may be attached to an axle as conditions may require. All brakes are of the same dimensions and are of the two disc type.

An electric crane of 10 tons capacity serves the entire space occupied by the plant. By its use the supporting axles with their wheels and pedestals may be easily moved about as conditions may require.

Means for bringing the locomotive safely to its position on the plant form an important part of the installation, and the facilities for securing observed data are unusually complete.



LOCOMOTIVE TESTING PLANT OF THE PENNSYLVANIA RAILROAD SYSTEM AT THE LOUISIANA PURCHASE EXPOSITION. END ELEVATION.

MIDDLESBROUGH DOCK ELECTRIC AND HYDRAULIC POWER PLANT.

Mr. Vincent L. Raven, Chief Assistant Mechanical Engineer, North-Eastern Railway, described the installation and the tests which have been made at Middlesbrough Dock, on the North-Eastern Railway, comparing hydraulic with electric appliances. These are working side by side, and give an excellent opportunity for judging the value of one against the other, so far as economy in working is concerned.

The traffic department find the electric cranes to be a great advantage. There is very little time required for oiling, as the crane has ring lubricators to all main bearings, and the wheels run in oil-baths which only require attention about once a month. The oil-bath effectually prolongs the life of the wheels and deadens any noise, which is a great advantage to the drivers in hearing instructions. The controlling of the crane by one handle is also a distinct advance both over the steam and the hydraulic cranes. With the steam cranes the driver had to attend to four levers and a foot-brake, in addition to the feed-pump and the firing of the boiler. In the case of the hydraulic crane two levers are in use which require considerable force.

The automatic cut-out in the electric cranes cuts off the current in one case at 3 tons 5 cwt., and the other at 10 tons 10 cwt., and this device prevents an overload upon the crane. Should the current fail at any time the brake on the lifting gear is applied automatically, and will hold the full load in any position with safety. To obtain some definite idea of the speeds of the various cranes when working under ordinary conditions, they were tested separately. The steam crane had a load of 2 tons put on, and this was lifted 30 ft., slued through 106·5 ft., lowered 30 ft., light hook lifted 30 ft., slued 106·5 ft., and light hook lowered 30 ft. The total time for these operations was 1 min. 44 sec., or at the rate of 34 cycles per hour.

The hydraulic cranes, under precisely the same conditions, occupied 1 min. 40 sec. per cycle, or equivalent to 36 cycles per hour.

The electric cranes did the same work in 64 seconds per cycle, or 56 cycles per hour, and this is capable of being increased beyond even this point with a good driver. Therefore in ordinary working the electric cranes are doing 50 per cent. more work per hour than the hydraulic or steam cranes. On actual test it was found that the electric cranes can be released from the rails, travelled 30 ft., and re-fixed to rails in 3 minutes.

When it has been necessary to move the hydraulic cranes to suit the working into the various ships' holds, six men have had to be called one hour earlier in the morning to set the four cranes which are required for each vessel. With the electric cranes the men have not to be called earlier, as two men in summer and four in winter can disconnect and connect up four cranes in 15 minutes. In winter, on frosty nights, four men have been employed six hours each for the purpose of keeping fires to prevent water in the cylinders of the hydraulic cranes from freezing; on the other hand, the electric cranes have no need of this. When a steam crane had to be got ready for work, the driver had to commence one hour earlier in order to obtain steam, whereas the hydraulic and electric cranes are ready for work at any moment.

INGENIOUS ENGLISH LOCOMOTIVE TESTING PLANT.

A description was furnished by Mr. G. J. Churchward, of the ingenious testing plant which has been installed at Swindon.

The Great Western Railway Company have recently put down in their erecting shop at Swindon a plant for testing locomotives. This machine consists of a bed made of cast-iron, bolted on a concrete foundation, with timber baulks interposed for the lessening of vibration. On this bed five pairs of bearings are arranged to slide longitudinally so that they may be adjusted for any centres of wheels that are to be put upon the plant. In these bearings axles are carried having wheels fitted with steel tyres, on which the locomotive runs. These axles are also fitted with drums on which band-brakes act for absorbing wholly or in part the power developed by the engine. Outside these band-brakes pulleys having an 18 in. face are provided at each end of the axle for driving link-belts, by which it is intended to transmit the major portion of the power developed by the engine to air-compressors so that it may not be wasted.

The hydraulic brakes will then only absorb just enough power to enable them to govern the speed of the engine. These brakes are actuated by a water-supply from an independent pump, the outlet of this water-supply being throttled either by a stop-valve or by a throttle actuated by a centrifugal governor. This latter device enables the speed of the engine to be set at any required number of revolutions and kept constant.

The carrying wheels are 4 ft. 1½ in. diameter. The main bearings are 14 in. long by 9 in. diameter. The tyre of the carrying wheels is turned to approximately the same section on the tread as the rails in use on our line. This plant is intended not only for the purpose of scientific experiment, but also to do away with the trial trips of new and repaired engines on the main line.

Under the platform a dynamometer enables the drawbar pull of the engine to be taken, and this, together with counters on the wheels, will enable the actual drawbar horse-power to be measured, and so compared with coal and water consumption for various classes of engines. As engines of different lengths are to be tested, and of necessity have to be fixed at the trailing end to the dynamometer, it is necessary to have a sliding chimney for carrying off the steam and smoke from the engine when running. This has been provided in the form of a long box, having a steel plate running on rollers forming its lower surface, which plate carries a large bell-mouthed chimney. This box not only enables the chimney to slide longitudinally, but will also form a receptacle for ashes and any other matter ejected by the engine, which will be retained and can be examined both for quantity and quality.

THE INSTITUTION OF MINING ENGINEERS.

FORTIETH GENERAL MEETING.

ABOUT eighty members of the Institution of Mining Engineers assembled in London for the Fortieth General Meeting, which opened at the Rooms of the Geological Society, in Piccadilly, Mr. James Cope Cadman (President) taking the chair. The meeting extended over two days, some of the papers being read concurrently in the Rooms of the Royal Astronomical Society, under the Chairmanship of Mr. H. C. Peake and Mr. G. A. Mitchell. Among those present were :—

Messrs. F. R. Atkinson, James Barrowman, B. H. Brough, Elmsley Coke, M. Deacon, A. Carrington Fowler, J. Gerrard, R. Guthrie, A. Hassam, H. Richardson Hewitt, J. A. Hood, W. B. L. Jackson, C. T. Leach, G. A. Lewis, Will Logan, J. A. Longden, Henry Louis, J. Mevin, J. Morison, H. B. Nash, H. Palmer, H. C. Peake, W. H. Pickering, H. Richardson, A. Smith, T. Turner and J. G. Weeks—members of Council.

Others present were : Messrs. S. Alsop, W. Armstrong, E. T. Bailey, H. Bannerman, Ellis Barraclough, M. Walton Brown (Secretary), H. T. Burls, G. M. Capell, W. S. Cheesman, C. L. Corlett, C. B. Crawshaw, Thos. Douglas, C. Chetwynd Ellison, T. English, T. Lindsay Galloway, G. A. Greener, Henry Hall, A. M. Hanshaw, R. Holiday, G. H. Hollingworth, W. B. M. Jackson, Herbert A. Jones, C. C. Leach, W. Wrench Lee, G. O. Lewis, R. H. Longbotham, D. A. Louis, George May, Mansfeldt Miller, D. Page, D. H. Patchell, H. Perkin, Douglas Pigot, W. Prile, H. D. Rodriguez, D. L. Selby-Bigge, E. Seymour-Wood, F. R. Simpson, G. P. Simpson, A. Smith, H. S. Smith, W. H. Trewartha-James, Sydney F. Walker, W. Wilkinson, W. B. Wilson, and T. P. Osborne Yale.

PRESIDENTIAL ADDRESS.

The President, in the course of his address, referred to the satisfactory progress of the Institution, which had now a membership of 2,688, including a considerable number of foreign and Colonial members. During the year no less than 79 papers had been read and discussed, and notes on 120 papers had been received from foreign and Colonial societies. He proceeded to announce that the Manchester Geological Society had joined their ranks, and expressed the hope that other societies would do the same. He particularly referred to the South Wales Institution and the Institution of Mining and Metallurgy, which were doing admirable work. He looked forward to the time when their Institute would be to the mining world what the Iron and Steel Institute was to the iron and steel industry, and saw no reason why their transactions should not be issued with the same regularity and much on the same lines as the institution referred to.

Discussing the Royal Commission on Coal Supplies, he said their final report was awaited with interest, and would probably show an increased quantity of available coal remaining to be got compared with that given in the report of the last Commission, although made 33 years ago, on account of the considerable extensions which had been discovered in many of the coalfields. In order to delay the time when coal would be imported into this country at a less cost from extensive and improved fields abroad, he advocated a more economic use of fuel. By sorting, sizing and washing to a refined degree he had known cases where the value of certain small coals had been increased by 200 per cent. The question was a very serious one in collieries working soft bituminous coals, yielding large percentages of small, and the necessity for the employment of such a plant was very obvious.

As to the report of the Departmental Committee on Electricity in Mines, it was pleasing to note that the Commissioners did not recommend any restrictions that would be likely to hamper the development of a source of power which bade fair to become an essential feature in the economic mining operations of the future. The effect that electrical power would play in the future, owing to its adaptability and efficiency, would no doubt be revolutionary. He anticipated the adoption of central power stations with gas engines driven by producer gas working electric generators, from which power would be distributed to the whole of a colliery, thus doing away with steam boilers and engines, and lessening the number of gigantic chimney stacks. (Hear, hear.) The President also alluded with satisfaction to the progress of technical education, and the opening of colleges, technical schools, or County Council classes, in nearly all the mining centres of Great Britain. They had received considerable support and encouragement from the Institution, but it was a work which was more or less of a national character, and much more help should be given by the Government ; it might even be suggested that a moiety of the tax levied upon the export of coal might very fittingly be allotted for this subject. The President referred with satisfaction to the Bill recently brought into force allowing two years of the time spent at a recognised college to count in the statutory period required by the Coal Mines Regulation Act in qualifying for the certificate of competency. He then touched upon the question of *ankylostomiasis*, the increasing output of coal mined in the United Kingdom, and the question of railway rates.

The President received a hearty vote of thanks for his address.

COAL MINING IN THE FARÖE ISLES.

MR. G. A. GREENER read a paper showing the conditions which obtain at the coal fields of the Faröe Islands :—

Coal has been found on four of the islands, namely : Myggenaes, Gaasholm, Vaagö and on Suderö. The deposits are not extensive, except those in the latter island.

The Faröe Islands are of volcanic origin. About 10 miles west-south-west of Suderö is the Faröe-bank, a large level plateau covered by about 50 to 70 fathoms of water. On the eastern side of this bank, about eight miles south 62 degrees west of Suderö, there is a large depression over 200 fathoms deep, and between the plateau and the island there are vertical rocks covered by 80 to 100 fathoms of water. This appears to have been the seat of the volcano, and its ejected lava formed the basalt rock, which is the seat or foundation of the coal formation. The ejection of lava from this volcano ceased, the basalt was covered with clay, and vegetable materials grew on this clay, where they are now found in the form of coal. Later, this volcano resumed its activity, and the whole of the islands were covered by immense beds of lava.

The eastern coast is indented with several deep inlets or fjords, making excellent harbours. Trangisvaag fjord is a splendid deep-water port, approximately four miles long by one mile broad. The coal-seams occur in the mountains surrounding this fjord and that of Qvalbo, in the north of the island. There is one workable seam over the area of over 6,000 acres of this coal-field, and there is evidence of the occurrence of other seams.

The coal is worked by adit-levels driven into the hillside, thus avoiding the heavy expenditure of shaft sinking. The mode of working is long wall, and very little timber is necessary as the roof is good and strong. Up to the present, there have been no signs of inflammable gas, and little water has been encountered. The miners are mostly Swedes, and all surface and offhand labour is done by Faröemen, but it is anticipated that in the future the latter will become capable miners. The seam yields two classes of coal, viz. : (1) A bright coal, similar to Welsh anthracite, breaking with a conchoidal fracture, and not soiling the fingers when touched ; and (2) a coal similar to English seam coal. The leading feature of the coal is its almost smokeless quality.

The paper was followed by a brief discussion, in which Mr. H. Mills, Mr. H. Richardson and Professor Henry Louis joined.

TIN MINING IN THE STRAITS SETTLEMENTS.

HINTS ON CHINESE LABOUR.

A PAPER by Mr. W. T. Saunders on "Tin Mining in the Straits Settlements" was read by the Secretary. It contained some practical hints on Chinese labour :—

Alluvial mining is carried on almost entirely on the western side of the peninsula, although large bodies of alluvial tin are known to exist on the eastern side. Some of these eastern areas in the State of Pahang have recently been leased from the Government for the purpose of extensive working.

Lode mining is in operation on the eastern side. The principal mines belong to the Pahang Corporation, Ltd. ; the Pahang Kabang, Ltd. ; the Royal Johore ; and the Bundy.

The most important mines are wrought by the Pahang Corporation, Ltd., and the Pahang Kabang, Ltd. These mines are situated about 40 miles up the river Kwantan from the port of Kwantan. Transport is carried on by steamer from Singapore to the port of Kwantan—a distance of about 225 miles —and thence to the mines by boats worked by Malays.

The principal workings of the Pahang Kabang, Ltd., are on Fraser's lode, present supplies being drawn from above adit-level. A shaft is now being sunk on this lode for deep developments. Another shaft is also being sunk on the Myah lode.

The formation is slate, the tin-bearing ground traversing the country-rock in an east-and-west direction. The lodes have a varying dip, sometimes to the north and sometimes to the south. They vary greatly in thickness, and, for the most part, are undefined by any distinct walls.

The stone from both mines is crushed in the same mill. The mineral is conveyed from the mines to the mill by a tramway of 2-ft. gauge, worked by two small locomotives.

The mill comprises a stamp-battery with 60 heads of 850 lb., vanner tables, buddles, grinding-pans, furnaces, etc. The monthly crushing averages about 3,500 tons. The stone varies greatly in value, the Pahang Corporation, Ltd., running from 2 to 2¾ per cent., and the Pahang Kabang, Ltd., bearing rather less to the ton.

The oxide carries from 71 to 72 per cent. of metal, which is a very high value compared with Cornwall, where tin-ore is rarely dressed higher than 65 per cent.

CHINESE LABOUR.

The labour is practically all Chinese. The native Malay, with very few exceptions, is absolutely useless for any work other than boating and procuring timber suitable for mining and structural purposes. The cost and the difficulty of obtaining timber have greatly handicapped the development of the mines.

The Chinese are procured from agents in Singapore for £5 to £6 per man, and are brought to the mines under an agreement to work 300 days. In compliance with their agreement, they are supplied with food and clothes, and sufficient money to purchase tobacco or opium. At the end of this agreement, they, in nearly every instance, continue in the service of the company as free men, and not infrequently (for them) build up big fortunes. As free labourers, they start at a wage equivalent to about 8d. per day, and advance as they become proficient as fitters, engine-drivers, miners, tin-dressers, etc., to £3 to £5 per month, and on contract-work frequently make considerably more. Some of the expert fitters are paid from £6 to £8 per month.

Whenever practicable all work is let by contract, the management dealing with the contractors, who engage their own gangs of labour and purchase their own tools, explosives, etc., from the company's stores, which are well-stocked with all necessary materials. The contract-price of driving levels runs from £4 to £7 per fathom (according to the nature of the rock). When the driving is done by machine-drills, the task is done by day-work, under constant European supervision.

The ordinary Chinese coolie, coming straight from China, being unaccustomed to the class of work (and method of doing it) to which he is put under European supervision, has to learn everything from the very

beginning, with the disadvantage of being unable to understand any European language and Europeans being equally unable to understand Chinese, for very few Europeans can speak the Chinese language.

In the Straits Settlements, the language universally spoken is Malay, and it is easily and quickly acquired by both Europeans and Chinese.

Like most (if not all) other races, the Chinaman is not a good workman when working by the day—in fact, he is inefficient; but, when working on contract or paid by results, he is an excellent workman and capable of performing a fair day's work. He is, however, very apt, and quickly acquires the method of doing work according to European ideas.

A good trait of the Chinese labourer is that when justly punished he bears no ill-will. It may be mentioned, however, that whatever punishment a European might inflict upon him for an offence, it is infinitesimal when compared with the punishment meted out to him in his own country.

From a European point of view, the Chinese are, perhaps, decidedly cruel amongst themselves, but one must bear in mind the fact that they are a people of a different race, and as regards nerves, temperament, etc., it must be remembered that they are very differently constituted from Europeans. The most satisfactory punishment for wrong-doing is financial, that is, to stop a portion of their pay, or to fine them. They feel a fine more severely than any other form of punishment.

The usual food of the Chinese is rice, salt and fresh fish, pork, poultry (especially ducks), and dried fruits and vegetables from their own country. Unlike Mohammedans and many of the Indian races, their religion does not prohibit them eating any food which takes their fancy, and they quickly accustom themselves to vegetables and meat produced in the country of their adoption.

The system usually adopted of feeding coolies is to allow the Mandor (equivalent to a European foreman) a certain amount of food and money to feed the gang in his kongsi (or building in which they are housed). Should these remarks be read by anyone employing Chinese labour and not accustomed to it, the writer would strongly advise that a sharp eye be kept upon the feeding of the coolies. Fear of the Mandor, and inability to express themselves properly in a European language, may for a considerable time prevent the fact of their being underfed and the Mandors making money on the food-allowance from coming under the notice of the Europeans in charge.

In the Straits Settlements, where most of the work is done by contract, the contractor takes over his coolies from the company, paying whatever they have cost for them. This is the best system for everyone concerned, as the contractor is alive to the fact that a badly fed coolie cannot work efficiently, and also, if he falls sick or dies, it is a considerable loss to the contractor personally. In the case of coolies employed at odd work (and in a mine or works a large number are usually so employed), a sharp eye should be kept on the food, etc., supplied to them, as the Chinese Mandor is indifferent to their condition of health, he suffers no loss if they die, and, in nearly every case, he will make as much as he can out of the coolies unless carefully watched.

The principal ailments of coolies in tropical and hot countries are malaria, acute diarrhœa, dysentery, and beri-beri — a disease peculiar to Asiatic and African races, in which the symptoms are much the same as dropsy. Mosquito bites also cause trouble.

The writer remarks that it would be money well spent if the Chinese were assisted with money grants in the building of a joss house (a house of religion). A few tom-toms and musical instruments should be kept in each kongsi, affording them a means of recreation, when the day's work is done, keeping them more or less contented and happy, and to some extent preventing them from seeking other and undesirable forms of amusement.

UNDERGROUND TEMPERATURES, ESPECIALLY IN COAL MINES.

THE SOURCES OF HEAT IN COAL SEAMS.

THE next paper, read by the Secretary, was that of Prof. Hans Hoefer on "Underground Temperatures, especially in Coal Mines." This paper was the outcome of observations made by the Professor in order that the Karlsbad and Teplitz hot springs might be protected from any possible interference by the working of the coal mines in the district.

The question now arose whether this warmth was really belonging to the coal-seam, or whether it might not be connected with the volcanic phenomena of this district, which, having begun with the eruption of basalts, phonolites and tephrites in Teritary age, are now gradually approaching their completion in the hot-springs of Karlsbad and Teplitz, and in the acid springs of Bilin, Krondorf-Gieshübel, and Franzensbad. He records that the abnormally high temperatures in the neighbourhood of Dux and Brüx cannot possibly be accounted for by the influence of the thermal springs—on the contrary the seam itself contains a large amount of natural heat.

It is universally accepted that coal has been formed from plants which have successively become turf, lignite, and brown coal, and which have, respectively, become black coal and anthracite. This metamorphosis is called carbonisation. By means of it, the carbon is, comparatively speaking, accumulated by more hydrogen and oxygen being separated. The products of this disintegration are water, carbon dioxide and marsh-gas (methane or CH_4), all of which, in fact, issue from coal-seams. It has been proved in north-west Bohemia that the gas issuing from brown coal contains a comparatively large amount of carbonic acid—certainly more than that contained in black coal. The carbon dioxide (CO_2) is a proof that an oxidation of carbon, a so-called silent combustion goes on during which heat is developed. In the formation of methane (CH_4), too, great quantities of heat are given off. We have then here already two important sources of heat in coal-seams, and the task now before us is to judge of it as to quantity.

Mr. F. Toldt, a friend of the writer's, undertook this calculation, and found that, in the case of the

formation of 1 kilogramme of brown coal from cellulose 4,048 calories were liberated, but in the transformation of brown coal into black coal only 1,407 calories.

FURTHER CONCLUSIONS.

(1) The process of carbonisation does not always develop an equal amount of heat, that at the brown coal stage greater quantities of heat are developed, and that therefore brown coal-seams must possess more natural heat than black coal-seams.

(2) As the heat liberated in black coal took a very long time to develop, therefore it could communicate it more equally to the neighbouring rocks, and is therefore less perceptible in the seams. Such a seam may be compared to an oven in which a fire, formerly kindled, only remains as a glow on the point of extinction, while at the brown-coal stage it may be compared to an over-heated oven.

The great natural heat of the north-west Bohemian brown coal-seam makes itself felt to the great inconvenience of the miner, as not only because the work done is less efficient, but also because during the process of carbonisation a large quantity of methane, or fire-damp, is thrown off. This necessitates a large amount of fresh air being brought in which, however, facilitates the oxidation or silent combustion of the already hot brown coal, so that fires in mines may easily occur. In north-western Bohemia, therefore, one is always exposed to the danger of a fire-damp explosion on the one hand and a fire in the mine on the other. The task of the mining engineer is to steer between these difficulties.

In the Brüx valley, they are only working one seam about 30 metres (100 ft.) in thickness.

If we summarise the foregoing conclusions, the fact remains (so often confirmed that we may consider it to be established), that certain coal-seams of the lower Miocene strata in the east as well as in the west of north-western Bohemia, contain an unusual degree of natural heat on being first opened, which can only be accounted for by a certain stage in the process of carbonisation and by the low-conducting power of the neighbouring clay formation.

This fact, which was of scientific as well as of practical interest, caused the Austrian Agricultural Minister to institute a similar inquiry in all the Austrian mines—as well in brown as in black coal, and especially in those places where shafts or cross-cuts had been driven towards a seam. Good maximum thermometers mounted in brass, with large mercury bulbs and degrees marked in 0·1 were used for the measurements.

The author reproduces the directions issued by the Minister of Agriculture and the Government Board of Mines in order to eliminate sources of error as far as possible, and to investigate the causes of disturbance of the normal distribution of heat in the earth.

In the course of the ensuing discussion, Mr. Bennett H. Brough said it appeared that in that part of Austria for some years past there had been a good deal of conflict and acrimony between the authorities who had charge of the springs, and the coal miners, it being alleged that the collieries were tapping the Karlsbad spring, which had been such a marvellous source of wealth to the district. The coal miners said they were doing nothing of the sort, and that the hot water they met with in the collieries had nothing whatever to do with the hot springs, and, of course, Dr. Hoefer's views represented the views of the coal-mining side. But a paper was recently published in the Transactions of the Austrian Geological Survey giving quite the opposite view and blaming the coal miners for what they were doing. It would be rather premature to form an absolute opinion as to what the truth was, but one would watch with very great interest the results of the elaborate inquiry of the Austrian Government.

THE HAMMER-FENNEL TACHYOMETER THEODOLITE.

A PAPER by Mr. Adolphus F. Eoll described the above instrument, which, he remarks, might be more adequately designated the tachytacheometer, since by one sight both the distance and the difference of altitude can (with D—Constant = 100, and h—Constant = 20) be practically read from a vertically held staff—thus reducing tacheometric operations to the simplicity of ordinary levellings—affording thereby a great saving of time and labour, and accordingly rendering general tacheometry more productive without any sacrifice in accuracy.

The characteristic feature of this instrument is that, resting upon a trunnion of the Porro-telescope and close to an aperature in its tube is a diagram of certain curves (on glass, similar to a magic-lantern slide), which can be viewed, at the same time as the tacheometer-staff, by means of the extra optical system provided within the tube of the telescope.

The tachy-tacheometer is made by Messrs. Otto Fennel Söhne, in Cassel. A description of the instrument, by Prof. E. Hammer, has been published as a pamphlet, and it has also been described in various German technical periodicals

The instrument is not limited for use only with staves bearing metrical graduations: the use being independent of the unit of measurement; and this, in addition to the special features alluded to above, induces the writer to predict that it will be largely used in the future.

THE USE OF ELECTRICITY IN MINES.

MR. S. F. WALKER read an able paper on the "Report of the Departmental Committee on the use of Electricity in Mines." After a reference to the thoroughly practical nature of the investigation, and the liberal spirit embodied in the Report, he remarks that a perusal of the latter leaves one with a feeling that the fear which was so commonly expressed, when the inquiry was first instituted, that the development of the use of electricity in coal-mines would be restricted, was unfounded.

THE PROPOSED SPECIAL RULES.

In the proposed Special Rules, however, the liberal sentiments expressed in the Report, and the practical line taken in the inquiry appear to have been given a

second place. The fears which were expressed at the commencement of the inquiry will have a very substantial foundation, if the proposed Special Rules become law.

The first thing which strikes an observer is the great length of the proposed rules. Considering the present number of the General and Special Rules, it would have been thought that a few simple rules covering the main lines upon which electrical development will proceed, would have been sufficient for the purpose in hand, namely: The protection of life and property. A few simple rules, on these lines, would be of great service to the colliery manager. A number of rules, such as those suggested, can only be a great hindrance, and must lead to the throttling of the development of the use of electricity. The writer submits a few simple rules, which he suggests will meet the objects the committee had in view.

Incidentally he remarks that the rules that are adopted should be specially adapted to the conditions of mining, and that it would be wise to break away from departmental tradition on the one hand, and to avoid a slavish imitation of methods in other branches of industry where electricity is employed. Grave mistakes have been made in the development of electricity in the lighting of towns, and in power distribution, and the success which has attended those industries, not always financially great, have been in spite of these grave errors. If they are to be carried into mining work, the results may be disastrous.

The division of installations into low, medium, high and extra-high pressures, is good for the Board of Trade, for work that they have to supervise, though British electrical engineers complain bitterly of the way in which the industry has been cramped by Parliamentary action and Board of Trade supervision; but for mining work the division renders the work of the colliery manager additionally and needlessly puzzling. Many of the rules for medium pressures should be applied equally to low pressures, if the maximum security is to be obtained; and again, many of the rules for medium pressures are repeated for high pressures, as though they were applicable only to those. Why should the colliery manager be puzzled in this way? He wants help, not obstruction.

In many of the Special Rules terms are used which will be unfamiliar to mining engineers, and are really inapplicable, such as "feeders." Again, the term "live metal," although applicable, should hardly have been used without explanation. Many of the Special Rules also are very vague, thus fuses are to go "on short circuit," or with 100 per cent. increase of current. A rule of this kind can only be misleading. If a fuse goes with 100 per cent. of increase of current, it must go on "short circuit," unless the conditions are very special, and such as would hardly require the protection of a fuse.

One of the few points on which the writer disagrees with the Committee in their Report, is the way in which "earth" is dealt with. Cables carrying currents above 650 volts pressure are to be enclosed in armour or in metal pipes, the armour, or the pipes being earthed. Also, all cases, etc., as described in the second suggested Special Rule, are to be earthed. The writer is very strongly of opinion that cables should only be armoured in certain special cases, as in that of a three-phase cable in a shaft, and that the wisdom of earthing everything is doubtful. His view is that "earth" should be kept out of, and away from any electrical service everywhere, but especially in collieries. He would permit "earth" in special cases, but he would rather not use it.

THE AUTHOR'S SUGGESTED SPECIAL RULES.

These are as follows:—

(1) Pressures, exceeding 3,000 volts, shall not be used anywhere in or about a mine, and pressures above 650 volts shall not be used outside the main intake airways, or chambers supplied directly from the main intake airways without the permission in writing of H.M. Inspector of Mines in charge of the district.

(2) All machine carcases, cases enclosing switches and fuses, and any other metals (excluding nails and screws) used to protect or to support conductors belonging to the electrical service, but not in conductive connection with the service, shall be connected to earth, except in cases specially exempted by H.M. Inspector in charge of the district.

(3) No part of the conductive system of an electrical service at a mine shall be connected to earth, except by special permission of H.M. Inspector of Mines in charge of the district.

(4) All electrical apparatus in use at a mine shall be so fixed and maintained that in the ordinary working of the mine: (*a*) No part of the apparatus shall become unduly heated; (*b*) no arc shall be formed in any part of any apparatus; and (*c*) it shall not be possible for those using or engaged in the use of the apparatus to get a shock, while carrying out their duties in a proper manner.

(5) All cables and machinery shall be tested not less than once a week for insulation, with a current whose pressure is not less than that of the working current, the tests being recorded in a book provided for the purpose, and the insulation of the whole of the apparatus must be maintained in such condition that the leakage current at any instant is not greater than 0·0001 of the maximum total current.

(6) All connections between service cables and generators, motors, transformers and lamps shall be properly controlled by switches, and protected by fuses or electro-magnetic apparatus, in such a manner that No. 4 Rule is fully complied with, and in those portions of mines where No. 8 General Rule applies, all switches, fuses, junctions and between cables and any places where the circuit is made and broken, shall be enclosed in gas-and-flame-tight boxes. Where trailing cables are used in connection with machinery in motion, or for shot-firing, a connection shall not be made with the supply service, until a connection has been made with the motor, or fuses, and everything arranged and no electric motor shall be worked in an explosive atmosphere.

In the suggested Special Rules the idea has been to follow the spirit of the Coal Mines Regulation Acts, and to make use of the machinery provided in them, so far as it is available, and so to avoid the necessity of further burdening the already heavily weighted colliery manager. The idea has also been to develop the principle of responsibility, in place of attempting to provide leading strings. The writer's view is that, while if you enact that certain perfectly practicable things are to be done, and you hold a given official responsible for their being done efficiently, all experience shows that they will be done; while if you endeavour to provide for every contingency, with the idea that you are assisting those who have to carry out rules, you bar out the best class of men, those who are not afraid to accept responsibility, and you provide innumerable loopholes for the devolution of responsibility, while you have not really added to the safety of the apparatus.

The qualifications of the proposed electrical engineer will vary with the size of the plant and with the size of the colliery. One important qualification that he

must have is familiarity with mines. In the writer's view, probably, for large firms, the best man to be found would be a mining engineer who had qualified in electricity and mechanics. What is wanted for the work is, not a knowledge of the latest theory of electricity, but an intimate acquaintance with mining conditions, and the ability to instruct his men in the way of quickly putting little things right.

Mr. W. C. Mountain said the rules were at present under consideration by the Institution of Electrical Engineers. There was to be a meeting that afternoon to consider some of the most important points from an electrical point of view, and on the following day a discussion with the Committee of the Mining Association of Great Britain, and then, when they all knew exactly what they did want, it was proposed to approach the Home Office. He did not think the rules suggested by the author were quite sufficient to show what it was necessary to do to protect life. At the same time he thought the proposed special rules might require some amendment.

In the course of further discussion, Mr. Roslyn Holiday said they had lately found out that if the proposed rules were passed as they now stood it would mean shutting up the collieries. As the rules stood at present, it would appear that if a manager wished to put a bell in his office he had first of all to acquaint the Inspector with the fact that he was going to put in an electrical installation. In fact, as one read the rules they would seem to involve great trouble to the manager. He considered that the proposed rules threw too much responsibility upon the Inspector.

Mr. Gerrard (Mining Inspector) held strongly that mining and electrical engineers must pull together. H.M. Inspectors would ask members to give them that help in administering the rules which they had on all previous occasions given, and the Inspectors would try to meet them in the best and most reasonable spirit.

The paper was discussed at some length, and in the course of his reply Mr. Walker said the greatest justification for the remarks he had made was to be found in the discussion, which showed that nobody was satisfied with the draft rules, and that everybody hoped they would be modified, though nobody could say how they should be altered.

THREE-PHASE AND CONTINUOUS CURRENTS FOR MINING PURPOSES.

A GREAT deal of interest centred in the "Comparison of Three-Phase and Continuous Currents for Mining Purposes," presented by Mr. Roslyn Holiday, and based upon practical experience. We quote the following from his remarks on the three-phase system :—

THREE-PHASE.

The special feature about the three-phase system is the motors. These consist of a circular stationary case, wound with three series of coils, termed the stator and a revolving drum (either wound with three series of coils or covered with a squirrel-cage formation of copper bars) termed the rotor. The high-pressure current is supplied direct to the stator coils, the rotor need have no connection from outside, as any current flowing there is generated by induction, and is at a very low pressure.

Up to 30 horse-power, these motors can be started without the use of any resistances or other complications. The writer has used a number of these for driving coal-cutting machines, and as far as he knows, he was the first in this country to use three-phase current for this purpose. With larger sizes of motors, there are two principal systems of starting in use at present. One is by means of a special form of switch and small transformer combined, termed an auto-transformer, in the main circuit. In the other system, there is a three-pole switch in the main circuit, and on the rotor-shaft there are three insulated brass rings, connected to each of the three series of rotor-coils. From these rings, the current is led to an arrangement of variable resistances. For motors up to 30 horse-power, the first-mentioned method of starting cannot be beaten for absolute simplicity, and this is essential for motors used to drive coal-cutting machines. These motors can also be reversed from full speed in one direction to full speed in the opposite direction, without shutting off the current. This facility of reversal is of great use in coal-cutters of the disc type, as a disc jammed by a piece of cubical coal wedged cornerwise, and which would take great power to crush the piece of coal, can be liberated instantly by reversing the motor for a few seconds.

Three-phase motors cannot by any simple means be made to run continuously at various speeds. The speed does not vary with the voltage of the current, but depends approximately on the periodicity of the current supplied, and the number of pairs of poles on the motor ; thus the speed of a six-pole motor per minute with a current frequency of 50 per second is found thus : The number of periods per minute divided by the number of the pairs of poles equals the number of revolutions per minute or ($50 \times 60 \div 3 =$) 1,000 revolutions per minute.

When this condition obtains, the motor is said to be running in step with the driving current. If the motor be sufficiently overloaded, it is pulled out of step and comes to rest. The writer finds that if this takes place when coal-cutting there is a very considerable increase in the flow of current, but that it is not such as almost immediately to burn the motor in the event of the fuses not blowing. In fact, even if the attendant is engaged fixing timber behind the machine when it is pulled up, by the time he has got to it and switched off, there is no perceptible rise in temperature of the motor. This fact is due to the motor, even when stationary, having by induction a choking effect on the current, and so preventing its rising to dangerous proportions. This feature of three-phase motors is found of the greatest benefit in coal-cutting, for should the cables be short circuited, the fuses would be instantly blown, but they are not blown every time the cutter is jammed ; in fact, the writer, in his experience, has not known of a single instance of a fuse being blown through this cause. As a consequence, he has placed the fuses on the surface only, thus removing from the pit one of the possible sources of danger.

One disadvantage of the three-phase system is, that it is necessary to use three wires for the motors, but, as later on the various points for or against the two systems are compared, this will be given its due place and weight.

In fitting up a colliery with plant on the three-phase system, it is only necessary to have one type of generating plant, which is equally available either for lighting or power supply. The current is generated at a suitable pressure for transmission to the motors, and by means of static transformers it is transformed down to a pressure suitable for lighting.

The author also deals in detail with continuous current. He summarises his comparison as follows :—

In drawing a direct comparison between the two systems under consideration, it is found that it almost consists in stating the defects in the continuous-current system, and then on the other hand stating that these do not exist in three-phase system. With the continuous-current system, the high-pressure current is on the moving parts of dynamos and motors; there are commutators with their wear and tear, sparking and liability to breakdown; starting resistances are a necessity for motors. Transformers must be of the rotary type. With the three-phase system there is no high-pressure current on the moving parts of motors or dynamos; there are no commutators, therefore no sparking; starting resistances can be dispensed with; the pressure can be transformed up or down by means of static transformers. Continuous-current series wound motors start better against a load than three-phase motors, but, as has been shown, the armatures are very liable to being burnt out when used for driving coal-cutting machines.

With the exception of charging storage batteries, three-phase currents can be used for any purpose to which continuous currents can be applied. For efficiency, simplicity, and reliability the writer is strongly in favour of the three-phase system for use in mines. The writer has an alternator coupled direct to a steam-turbine of 200 h.p., and it has a small continuous current dynamo, as exciter, on the same spindle. This has run almost night and day since 1897 with absolutely no repairs, and the only part which to-day shows any signs of wear and tear is the commutator of the exciter.

The paper was followed by a discussion as to the merits of the respective systems by Messrs. Mountain, Channing, Jones, Galloway, Walker, Corlett, etc.

COMPRESSED-AIR LOCOMOTIVES FOR MINES.

THE Secretary read a paper on the above subject by Mr. Beverley S. Randolph. The writer expressed his conviction that the advisability of using electricity or compressed air for haulage is one which should be determined by the conditions obtaining in the particular case.

The pneumatic locomotive (illustrated in the paper) is large and cumbersome, and therefore not so well adapted to low seams as the electric locomotive, except where its safety in the presence of fire-damp may be held to counterbalance this disadvantage. The delays incident to charging are not so great as would at first appear, since, even in the best managed establishments there is more or less lost time at terminals which may be utilised for charging. Again, any unusual amount of work between charging stations, such as may be due to badly lubricated cars or assisting in replacing derailed cars, is liable to exhaust the supply of air in the tanks and necessitate to run to the charging station and back before the train can be brought forward.

On the other hand, electricity has never been successfully applied to the gathering of cars from the rooms or working places, owing to the expense involved in wiring each place and the difficulty in passing round short turns without displacing the trolley. A compressed air locomotive is very successful for this purpose. The small gathering locomotive has the same dimensions as the mine cars in the mine it was designed to work, and it can, at any time, travel on any road traversed by these cars.

The machinery used with compressed air so closely resembles that used with steam that mechanics familiar with the one have little to learn in managing the other. Steam is so generally understood that men competent to manage pneumatic plants are easily obtained, while experts in electricity are scarce.

The remainder of the paper was largely devoted to the question of relative cost, the author claiming that the electric plant is usually the more expensive.

The paper was discussed by the Rev. G. M. Capell and Messrs. S. F. Walker, H. Hall and Holiday.

THE EXPERIMENTS UNDERTAKEN BY THE BELGIAN DEPARTMENT OF MINING—ACCIDENTS AND FIRE-DAMP.

MR. V. WATTEYNE'S paper gave a useful synopsis showing the purpose and present state of the first experiments on safety lamps and explosives, carried out at the Frameries Experimental Station, under the auspices of the Belgian Government. These experiments are being carried out under exceptional conditions, as the following extracts show :—

Members are perhaps aware that, for the purpose of our experiments, we are in possession of a natural source of fire-damp of a high degree of purity, unexcelled in mining practice. Thus we are enabled to experiment with genuine pit-gas, which the writer regards as an essential factor in arriving at really conclusive results.

The apparatus used allows of the subjection of the lamps to the action of gaseous currents of any desired composition and velocity (up to as much as 60 ft. and 66 ft.) (18 and 20 metres) per second. Nor are these currents horizontal only, they are upward or downward, oblique or vertical. Moreover, the densest atmosphere known to exist in deep mines has been reproduced; and in Belgium there are several mines 3,000 ft. or even 4,000 ft. deep.

With the view of simulating all the diverse conditions met with in practice, experiments have been conducted not only in gas-laden atmospheres, but also in dusty atmospheres, wherein the proportions of dust and fire-damp were varied as desired, and with lamps which had been kept for several hours in the underground workings.

From the point of view of relighting the extreme case has been simulated wherein the lamp-gauze before extinction has become red-hot in an atmosphere charged with fire-damp, and the workman, ignorant or reckless of the danger, has immediately set the igniter at work without even waiting for the gauze to cool down.

Our experiments have not yet been brought to an end. Nevertheless, those which have been carried out in regard to lamps have reached a sufficiently advanced stage to permit of the following brief synopsis of some of the conclusions to which they lead :—

(1) The use of benzine does not diminish in any notable degree the safety of the lamps in which it is burnt.

(2) Several shielded or bonneted lamps, especially the Marsaut lamp and the Wolf benzine-lamp are shown to be considerably safer than the Mueseler lamp. The last-named, which shows a perfect capacity of resistance in horizontal currents, rapidly breaks down in upward currents.

(3) The internal igniter, if made of phosphorised paste and worked by friction only, may be often used without danger in the midst of atmospheres charged to extreme with fire-damp. This does not, however, apply to every type of lamp, especially not to the Mueseler, where the working of the igniter causes the flame to pass into the upper gauze.*

The paper also included a section on Explosives, the use of which in Belgium is hedged round with great stringency. But, says the author, now that we have at our disposal an experimental station allowing of a close personal study of safety-explosives; now that we are enabled to determine their practical value by fixing the maximum charge, that is, the highest charge that can be detonated without igniting the most dangerous mixture known of fire-damp and dust, it will be possible to remodel the regulations with greater effect, and bring them abreast of the most recent progress. The experiments are carried out in a gallery of the same dimensions as that usual in a mine, with genuine pit-gas, and with increasing charges of explosives which are detonated without stemming in an atmosphere charged with fire-damp, accompanied or unaccompanied by dust. It need scarcely be added that the power of the explosives is also determined, by the leaden block or Trauzl method. It is proposed to repeat some of the experiments, at all events, with stemming, so as to simulate as closely as possible the conditions which obtain in practice. Also to carry out experiments in smaller or partly-obstructed galleries; and finally to settle exactly the influence of dust on the limitation of the maximum charge, etc. The results of all these experiments will be published at a later date.

In the course of the ensuing discussion, Mr. H. Perkin expressed the opinion that if the Wolf lamp, which was lighted from an igniter underneath, were adopted in this country it would be rather a step in a backward direction; they could not trust every miner with an igniter on his lamp. They could not have a better system than that of a lighting station in charge of an experienced man to which the men could go with their lamps.

Mr. Hewitt (Assistant Inspector of Mines) disagreed with the author's view that the introduction of benzine did not cause additional danger. He thought they should not place too great facilities in the hands of colliers for getting a light.

Professor Louis emphasised the obligation they owed to the Belgian Government for this excellent experimental work.

After further remarks by Mr. A. M. Henshaw, the author (who was not present) was accorded a hearty vote of thanks for his paper.

ANKYLOSTOMIASIS.

DR. HALDANE and Dr. Boycott being present, a discussion on miners' anæmia was then initiated. The Secretary first read a communication from Mr. R. Simpson, of the Geological Survey of India, dealing with inquiries as to the prevalence of the disease in Indian coal mines.

Mr. J. Cadman, jun. (Assistant Inspector of Mines) expressed the opinion that there were many mines in North Staffordshire where the disease, if it was introduced, would no doubt soon become prevalent. He referred more especially to mines with steep inclination, where the temperature was high, and where there was a certain amount of water. He emphasised the importance of sanitation and the inspection of aliens.

Mr. H. Hall (Inspector of Mines) pointed out the difficulty of attempting sanitation in the pits, where there were neither sewers nor water. He called attention to the suggestion that the larvæ might be destroyed by a mixture of 2½ per cent. of salt with water.

Mr. Pickering (Inspector of Mines) described what was being done in Yorkshire by way of sanitation. He thought Dr. Boycott had rendered very valuable service in discovering the blood test.

Mr. Henshaw described the condition of certain pits as abominable in the extreme. He urged the necessity for sanitation, and pointed out that ideal conditions for the propagation of the disease existed in several collieries in North Staffordshire.

After further discussion by Messrs. Hewitt, Smith and Douglas, Mr. Gerrard (Inspector of Mines) described the elaborate precautions against the disease which are taken in Westphalia.

Mr. S. F. Walker pointed out the value of coal dust as a disinfectant in the mines, and some practical suggestions were made by Mr. Ellison.

Dr. Haldane then addressed the meeting at some length, and in the course of his remarks emphasised the necessity of getting rid of the fæces in the mines. He hoped that before long common measures would be devised and agreed upon in all the colliery districts of the country, to deal with the disease in the way of prevention. He quite agreed that quarantining was most important. If he had any responsibility in connection with a colliery he should certainly have all men examined who came from suspected districts, certainly those coming from Cornwall and Italy, besides those from India, South Africa, and any other place abroad, especially the tropics. The examination was a little troublesome. A good way was to take a sample of the blood, and a still better method, in individual cases, was to obtain a sample of the fæces and send it to a central laboratory.

Dr. Boycott also addressed the meeting, and the discussion closed with a vote of thanks to the medical experts for the information afforded.

Other papers included: "Work of Conveyers on Longwall Faces," by Mr. R. G. Ware; "Firing of Babcock Boilers with Coke-oven Gases," by Mr. T. Y. Greene; "The Transvaal Kromdraai Conglomerates," and "The Southern Rand Gold-Field," by Mr. A. R. Sawyer; "The Occurrence of Cinnabar in British Columbia," by Mr. G. F. Monckton; "The Prevention of Accidents in Winding," by Mr. J. H. Merivale, M.A.; "Petroleum, and its use for Illumination, Lubricating, and Fuel Purposes," by Dr. P. Dvorkovitz; "The Analytical Valuation of Gas Coals," by Mr. G. P. Lishman, D.Sc.; "A New Process of Chlorination for Mixed Gold and Silver Ores," by Mr. Horace F. Brown; "Graphite Mining in Ceylon and India. Part I.—Ceylon," by Mr. G. A. Stonier, A.R.S.M.

* In all these observations with regard to lamps the writer must be understood to exclude the electric lamp.

MINING ENGINEERS' MEETING

(Continued).

EXCURSION TO DOVER.

THE RECLAMATION AND EASTERN ARM OF THE ADMIRALTY HARBOUR AT DOVER.

BY

D. A. LOUIS, F.I.C., M.INST.M.E., M.A.I.M.E., F.C.S.

THE members of the Institution of Mining Engineers who visited Dover Colliery left London by a special train, and caught their first glimpse of the colliery as they approached the town. They were specially struck by what appeared to be a great pithead covered in, and by an unusually large number of cylindrical tanks, but curiosity concerning these matters was not to be satisfied until the afternoon, as the morning was to be devoted to the Admiralty Harbour Works and feeding.

The colliery is packed away on a ledge of rock alongside the South Eastern line, and immediately at the foot of a great perpendicular chalk cliff. The sea-front of the ledge is protected by a sea-wall, which is to be extended westward so as to reclaim a considerably large area from the sea, which in course of time will be filled up with waste from the pits and be used as a sorting yard for trucks when the colliery is behaving as a colliery should do, that is—producing coal. The present appearance of the ground is highly satisfactory, and shows that those who have the work in hand are doing it with thoroughness and earnestness.

The work in progress at the time of the visit was the sinking of shaft No. 2 by the Kind-Chaudron system. Three shafts were originally started, two of 20 ft. and one of 17 ft. diameter, however, when they got into the Hastings beds considerable difficulties were encountered, and only one shaft was continued; but in course of time that too had to be abandoned owing to the water difficulty. The present Corporation then took the matter in hand and decided to continue sinking the shafts without removing any of the water; all pumps were taken out, and there is quite a small museum of them now to be seen on the ground. The great pithead house, the "barraque," 64 ft. in general height, 80 ft. at the centre, 94 ft. long, and 30 ft. wide, was erected. It is a striking timber structure. The walking-beam, its working cylinder and the necessary tackle for handling the apparatus, were installed and work was duly started a year ago. The process of sinking the shaft is by percussive boring. The 20-ft. shaft has been gradually reduced in diameter so as ultimately to be 15 ft. across inside. When sinking, a small pit is first bored by means of the small cutting tool known as the small trepan. This is a steel framework carrying tool-steel teeth or chisels; it weighs 11 tons; it is screwed and suspended with an intervening Kind free-fall device at the end of a column of rods, is given a reciprocating motion from the walking-beam, and a slight turn between each stroke so as to cause the trepan to strike a new place each time. This operation was witnessed in progress. The result is that the rock below gets chipped and cut away, and when too much *debris* has collected in the hole, the rods and trepan are hauled up and the chips and mud cleared out by means of a bucket, which weighs 2 tons and holds 6 tons of stuff. The smaller hole is sunk 30 ft. or so, and then the big cutting tool or large trepan—a steel framework also with tool-steel teeth and weighing 27 tons—is put down, worked in the same way as the small trepan, and bores a hole the full size of the shaft. When the boring is complete the shaft will be lined with tubbing, which consists of cast iron rings about 15 ft. in diameter, about 4 ft. high, and varying in thickness from $1\frac{1}{4}$ in. to $4\frac{1}{2}$ in., and in weight from $7\frac{1}{2}$ to $17\frac{1}{2}$ tons each. Ther

are 278 of these, and the total weight of the tubbing will be 3,675 tons. These rings are all on the ground, arranged in the order in which they will be required; they stand in stacks of three, and are what were taken to be tanks when passing on the railway. Besides all these there are the various other parts required in the operation of putting in the lining. The moss-box, consisting of two steel cylinders, each 4 ft. high and 2¾ in. thick, one (15 ft. in diameter and weighing 12½ tons) which is made to fit telescopically over the other (14½ ft. in diameter and weighing 9½ tons); the sinking shoe, etc., together representing some 20 tons of iron and steel. A great cast-iron dome, strengthened with formidable ribs, and weighing 27 tons, was on view, and a lot of 10-in. piping in lengths of 10 ft. to form the equilibrium column, which will fit over the central orifice of the great dome, which is the diaphragm or false bottom to be used while the tubbing is being let down into the shaft.

There were at work to keep things going a battery of boilers which supplied two geared winding engines, which, with various winches, are used for working and handling tools and material. A great show of moss, 4 tons, attracted attention. It is to form the packing in the moss-box and amongst other things a massive timber gantry for landing this heavy material, which has been shipped from Germany by Messrs. Haniel and Lueg, of Düsseldorf, who have the work in hand. There was also a remarkable condensing plant, consisting of a tall cylinder—there will be two—built of ordinary tubbing segments, in which a 30-ft. Galloway boiler is fixed vertically.

The visitors were received by Mr. W. J. Cousins and some other directors; and Mr. F. W. North, the consulting engineer, with Mr. T. J. Newton, the manager, were in attendance.

ADMIRALTY HARBOUR, DOVER.

The official memorandum issued to members reminds us that this work is being carried out by Messrs. S. Pearson and Son, Ltd., under the superintendence of Messrs. Coode, Son and Matthews. The staging for the Admiralty pier extension was commenced in January, 1899, and by the end of the year ten bays of 50 ft. were erected with the plant, consisting of a 20-ton derrick, 50 ft. radius, for handling staging material, a 60-ton goliath for taking out the foundations with grab and bell, and two 40-ton goliaths for blocksetting; the first block being set in December, 1899. The foundation of the head is now being completed, and it is anticipated that all blocksetting will be finished in two or three months' time; 17 bays of staging, or 850 ft., have been in use at one time, dismantling from the shore end as it advanced seawards. There have been no losses of any account to the permanent work during its construction, nor any very serious damage to the temporary staging. Further particulars of the undertaking will be found in PAGE'S MAGAZINE of February last.

PLAN OF MINERAL AREAS BELONGING TO THE CORPORATION IMMEDIATELY SURROUNDING THE DOVER COLLIERY.

APPROACH TO THE CAVES AT CHISLEHURST.

The Members of the Institute of Mining Engineers visit the Caves at Chislehurst; the Holborn to Strand Improvement; and the Works of Messrs. Fraser and Chalmers, Ltd., Erith.

The other excursions undertaken by the members of the Institution were not so far afield, comprising an inspection of the subway and other works in connection with the Holborn to Strand Improvement, a tour of the caves at Chislehurst, and a visit to the works of Messrs. Fraser and Chalmers, Ltd., at Erith.

ALDWYCH AND KINGSWAY.

Details of the work now in progress were given in PAGE'S MAGAZINE as recently as March last. The brief account of the work issued to members states that the cost of the sub-structure of Kingsway, inclusive of the tramway subway, is said to be close on £100 per lineal foot, or over £5,000,000 per mile.

The tramway subway, provided for two lines of rails, is 20 ft. wide by 16 ft. 3 in. maximum height. The arching consists of five rings of brickwork, the inner ring of which is glazed. The side walls are of concrete, and the whole tunnel is surrounded by a layer of asphalte ¾ in. thick. The tunnel will be fitted for traction on the conduit-system; it is practically finished for a length of 400 ft. north of the Strand, along the north-western side of the Gaiety Theatre. This portion has been constructed on the cut-and-cover system. In crossing the Strand and Holborn, however, it is intended to substitute a couple of tubes, driven by means of the Greathead shield, each 15 ft. 10 in. in diameter outside, for the single tunnel used elsewhere. The excavators will not have the benefit of working exclusively in the London clay, the upper portion of the shield will be driven through gravel, in which some water is likely to be encountered. On a portion of the line of route, the arch used in the deep-level section near the Strand, is replaced by steel troughing.

THE CAVES AT CHISLEHURST.

These caves, which are approached through delightful scenery, are very extensive, the ground being literally honeycombed with excavations cut out in the chalk. The chief guide (Mr. H. Slatter) showed us a remarkable labyrinth of chambers planned in the form of an ellipse, a flint-lined well, covered-in deneholes,* and other work ascribed to the ancient Britons. In reply to inquiries it was stated that Roman pottery has been found, and in one part of the workings the guide pointed out a series of chambers in the form of a cross and supposed to have been used by the early Christians. The electric light has been installed in a portion of the caves, though, unlike the Cheddar installation, the current is not "generated on the premises." The excursion proved an interesting one, and afforded the opportunity for much discussion, as to the origin of the workings, and the period from which they are likely to date.

* Deep and narrow shafts sunk through the Thanet sand into the chalk; they are connected with subterranean chambers supposed to have been used for the storage of grain and for refuge in case of attack.

Visit to the Works of Messrs. Fraser and Chalmers, Ltd., at Frith.

Specially Illustrated.

On the Saturday morning a large party journeyed to Erith to inspect the works of Messrs. Fraser and Chalmers, Ltd., where a quantity of mining machinery of the latest type was to be seen, either ready for shipment or in process of completion. The visitors were received by Mr. Walter McDermott (Managing Director), Mr. E. K. Sancton (Manager), Mr. J. I. Wile, and Mr. C. B. Hale of the engineering staff. The accompanying photographs were specially taken for PAGE'S MAGAZINE on the morning of the visit by Messrs. W. Watson and Sons, of High Holborn. An account of the methods employed, which are of considerable interest to photographers, will be found on page 56, under "Engineering Photography."

The members made a complete tour of the works in small parties, an arrangement which rendered it possible for those interested in special machinery to obtain the fullest information. A large share of attention fell to the various types of Corliss winding engines, which are made by this firm for use in all parts of the world, and erected complete in the shops before shipment. Most of the winding engines in the shop were for English collieries, including the plant shown in course of erection on the opposite page, which is intended for the Earl of Dudley's collieries and is the largest ever sent out from these works. It is a four-cylinder direct-acting winding engine, with double tandem compound Corliss engines, the Corliss cylinders being 26 in. diameter high-pressure, and 45 in. low-pressure, by 66-in. stroke. The winding drum, not shown in the photograph, is double conical; it has a maximum diameter of 18 ft. and is 10 ft. 6 in. wide. The maximum coal load is 7 tons, and can be lifted from a depth of 1,800 ft. at a rope speed of 3,500 ft. per minute.

Another of these machines is being erected for the Tasmania Gold Mining Co., Ltd. The winder in this case will hoist from a depth of 2,000 ft. at a maximum rope speed of 1,600 ft. per minute, the normal capacity of the winder being 50 tons per hour. Other large winders are being erected for Messrs. Penrychriber

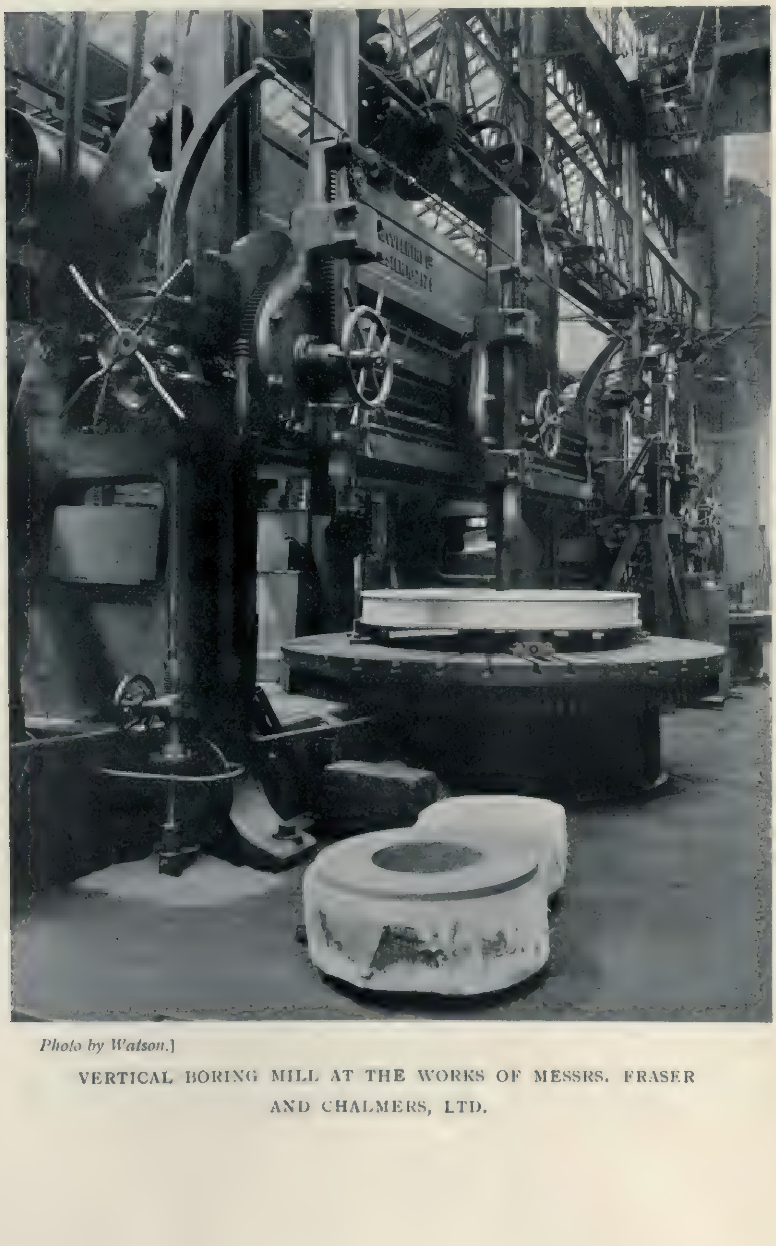


Photo by Watson.]

VERTICAL BORING MILL AT THE WORKS OF MESSRS. FRASER AND CHALMERS, LTD.

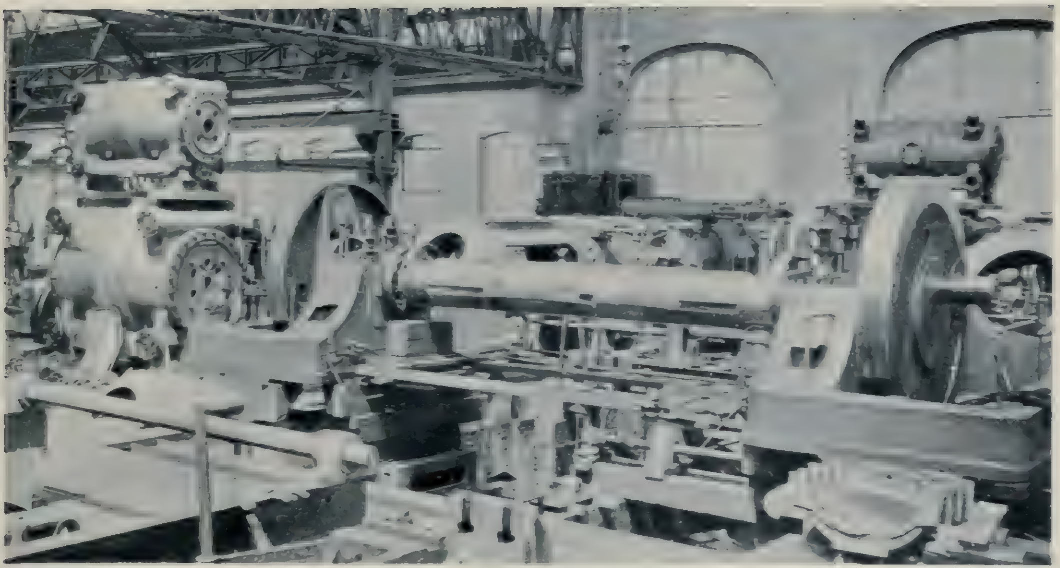


Photo by Watson.]

FIG. I. FOUR-CYLINDER COMPOUND CORLISS WINDING ENGINE.
For the Earl of Dudley's Colliery.

Photo by Watson.]

FIG. 2. VIEW IN MAIN MACHINE SHOP AT THE ERITH WORKS.
The spiral part of a winding drum is seen in foreground.

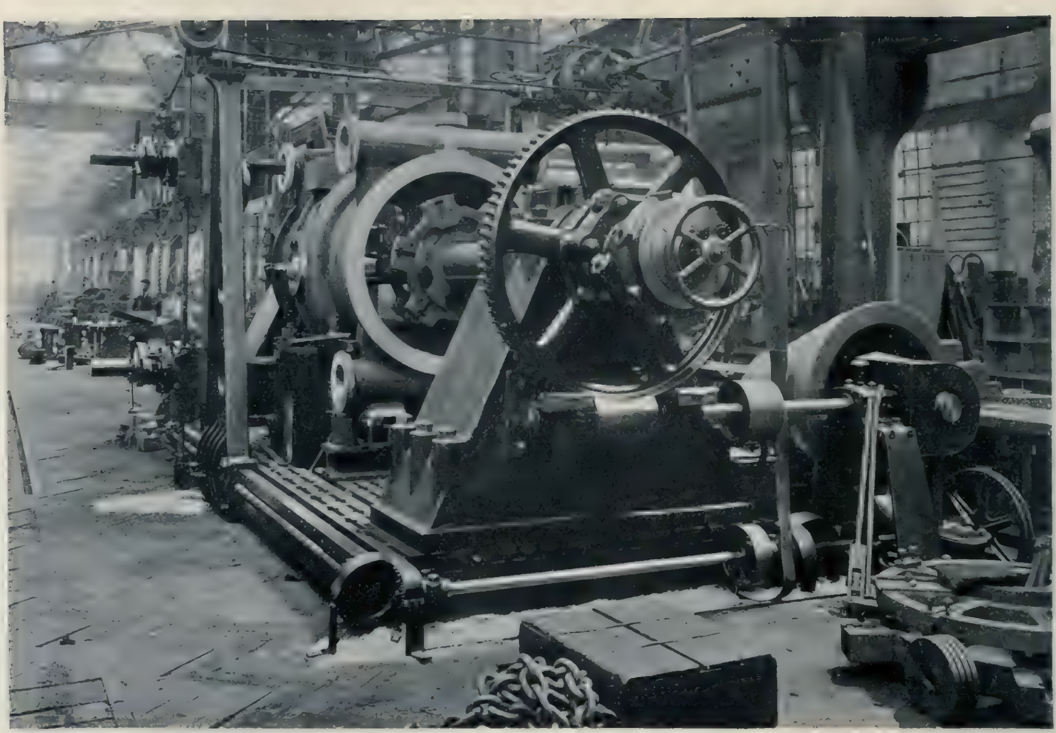


Photo by Watson.]

HORIZONTAL BORING MILL AT THE ERITH WORKS.
Machining Corliss Cylinder and Valve Ports simultaneously.

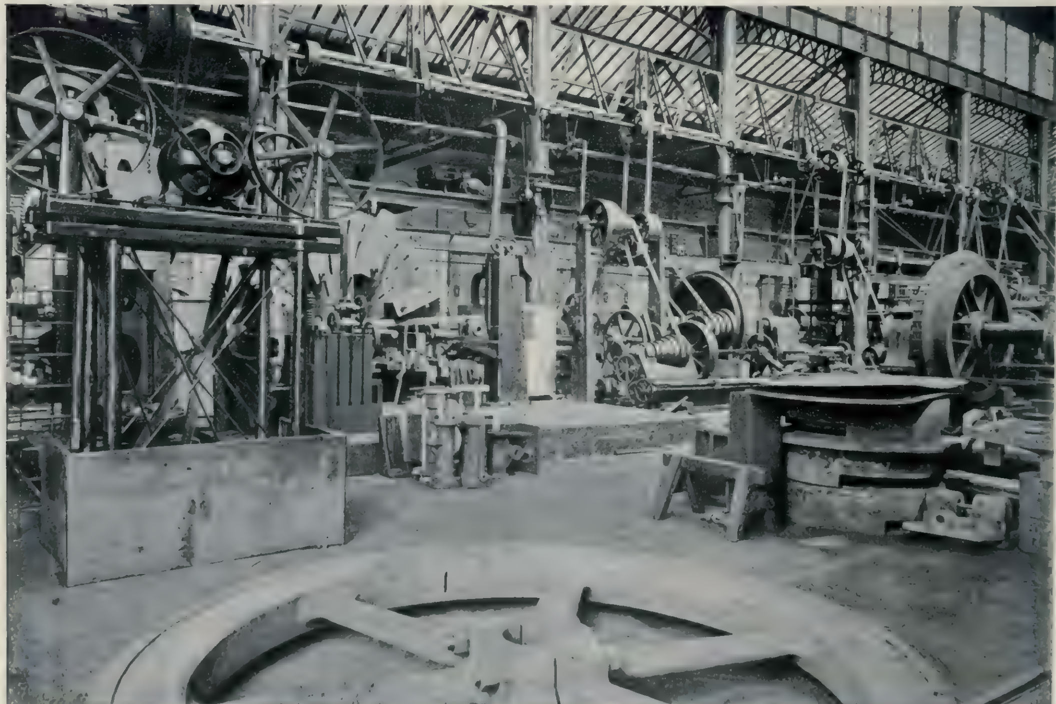


Photo by Watson.]

VIEW IN MAIN MACHINE SHOP AT ERITH, SHOWING HEAVY MACHINE TOOLS.

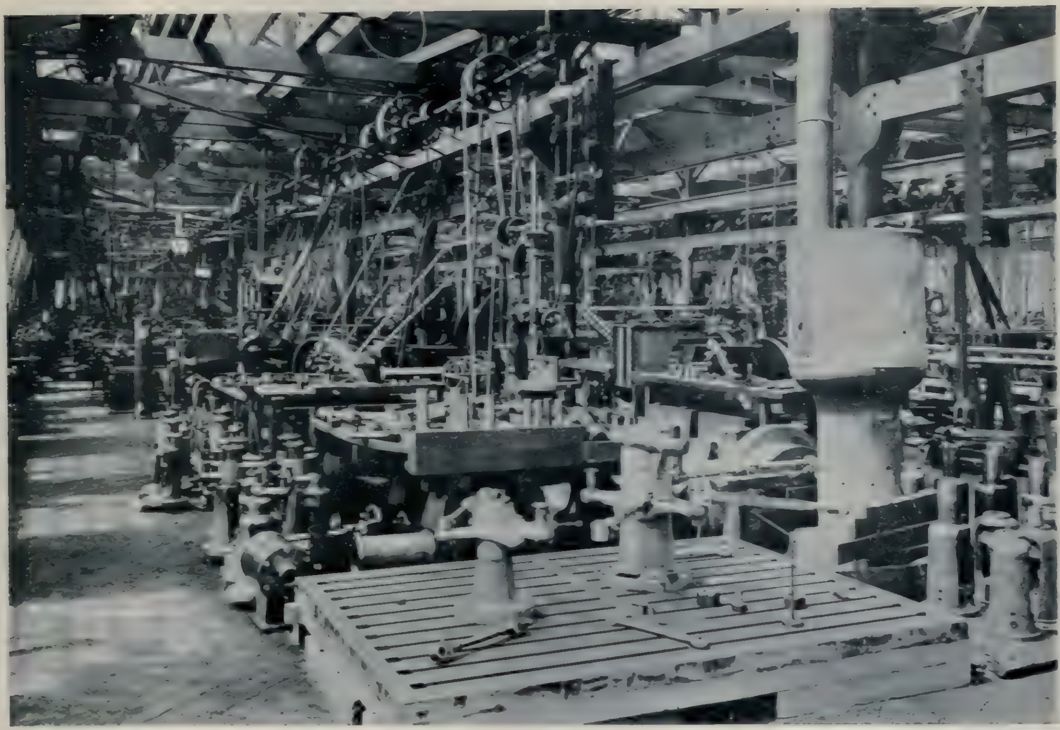


Photo by Watson.]

ANOTHER VIEW IN THE SAME SHOP, SHOWING LIGHT MACHINE TOOLS.

Navigation Collieries, Naths Navigation Collieries and Bridgwater Trustees.

A good deal of time was occupied in examining valve gear, levers for stopping and starting, clutches, Fraser and Chalmers' patent safety brakes, and other details of the winding apparatus, and visitors had an opportunity of comparing the merits of the round rope and flat rope methods of winding, and of studying the latest improvements in rock drills and other mining and metallurgical machinery. A large Riedler pump was shown at work pumping 175 gallons per minute with 600-ft. head working at 150 revolutions per minute with very little noise. In the foundry much interest was displayed in the casting of spiral drums used for the winders (one end of a spiral drum is shown on page 53), while in the adjoining yard were to be seen a number of rock breakers, ore bins, etc., ready for dispatch.

Specially noticeable were a number of cyanide vats in course of erection, prior to their dispatch to South Africa. The firm at the present time has on hand some 18 of these 50-ft. vats. Much interest was also taken in Messrs. Fraser and Chalmers' system of keeping drawings and plans, a thoroughly efficient card classification being employed. The spacious shops at Erith are admirably situated, and the room for extension is practically unlimited.

At the close of the inspection the members of the party assembled in the staff dining-room where light refreshments were hospitably dispensed.

THE ANNUAL DINNER.

The annual dinner of the Institution of Mining Engineers was held on the Thursday evening at the Holborn Restaurant, Mr. James Cope Cadman (President) in the chair. As usual, the function proved most enjoyable, and among the guests were Mr. Henning Jennings, President of the Institution of Mining and Metallurgy, and Sir William White, President of the Institution of Civil Engineers.

PHOTOGRAPHY FOR ENGINEERS.

IN opening a section of the Magazine for the discussion of Engineering Photography, we realise the growing importance of the functions which the camera plays in the development of the industries with which this Magazine is concerned.

We cordially invite our readers to utilise these columns for the ventilation of difficulties and the placing on record of points of interest determined. At the same time, we hope from time to time to call attention to new developments in photography which are likely to be of special use to engineers.

Photography in Works.

Now that photography is becoming so generally utilised for business purposes, it is not surprising to find engineering firms including photographic apparatus in their regular equipment, either for taking records of their productions, or for securing reliable data of work in progress at a distance from headquarters.

For photography in the works, where the weight is of no practical consequence, Messrs. W. Watson and Sons, of 313, High Holborn, who make a special feature of this class of apparatus, usually recommend a square pattern camera, provided with very long extension, for taking large size pictures of small parts of machinery, and having rising front and swing back in both directions. Strength and solidity to provide for any amount of hard wear and tear are most desirable, and are made a first consideration in such cameras as the "Premier," which has been specially designed for engineers.

Where the work to be photographed is away from home, or in different places, as in case of railway construction, mining, etc., and the apparatus has to be carried about, a lighter form of camera, such as the "Acme," is desirable, but in this case also strength and rigidity are points to be insisted upon.

Choice of Lens.

The choice of a lens is, of course, another point of the very greatest importance. The engineer's work may be large or small, the space in which it is to be photographed ample or confined. These conditions would formerly have necessitated two or three separate lenses of different foci, but Messrs. Watson have overcome the difficulty by producing a new lens, the convertible "Holostigmat," which offers the choice of three different foci, the two components being perfect lenses in themselves, and, in conjunction, forming a medium angle lens of extreme rapidity, with perfect definition.

Some Examples.

The work of these lenses is well illustrated in the preceding pages, the views taken in the works of Messrs. Fraser and Chalmers, Ltd., having been taken by Messrs. Watson, under the following conditions :—

The lower view on page 54 (heavy machine tools) was taken on an 8½-in. by 6½-in. plate with a series I Holostigmat ½-plate lens, 6½-in. focus, with stop *f*/22. All these views, except the one shown on page 52, have been slightly trimmed at the top, but none of the photos have been re-touched.

The photo of four-cylinder compound Corliss winding engine (page 53) was taken with the same lense, but with stop *f* 16. Only a portion of this photo has been reproduced same size. All the other views are reduced from photos 8-in. by 6½-in.

The view of vertical boring mill (page 52), the lower view of main machine shop (page 53), and the horizontal boring machine (page 54) were taken on the same size plate with series I Holostigmat whole plate lens, 8½-in. focus, stop *f/16*. The view in main machine shop, showing light machine tools (page 55) was taken under similar conditions with stop *f*/22.

The Development of Photo-Copies.

The following hints on the development of photo-copies are given in a new pamphlet issued by Messrs. B. J. Hall and Co., dealing with appliances for photo-printing by the electric arc :—

Ferro-Prussiate Papers.

After removal from the frame, the print must be thoroughly washed in clean water until the lines become white. The print may be plunged into a bath filled with water, or laid face upwards in an empty bath and thoroughly flushed over by means of an indiarubber pipe. When the lines are white, hang the print up to dry. It is better to use clean water for every print when possible. Over-exposed prints may be restored by using tonic ; under-exposed prints may be slightly intensified by using a weak solution of sulphuric acid. In either case they must be thoroughly washed afterwards.

Ferro-Gallic Papers.

Water Bath.—Plunge the print face downwards in a bath having a depth of not less than 1½ in. of clean water, carefully rub over back to expel all air bubbles, and leave for a minute or two, until the line becomes black and the ground white. The development is more rapid with water at a temperature of 70 deg. or 80 deg. F. Flush off thoroughly with clean water, and hang up to dry.

If the print has a mauve ground, exposure to the light has been insufficient. Over-exposure will whiten the ground, but weaken the lines. Broken lines are due to bad contact when placing the tracing and sensitised paper in the frame ; this may be avoided by using greater care. Violet lines result from the ink on the original being too weak, and in consequence allowing a portion of the light to penetrate the line and affect the paper below. In preparation of originals it is not necessary that the lines should be wide, *but they must have body.*

Acid Bath.—Lay the print, face upwards, on the glass bottom of an empty water bath, pour upon it a tumblerful of developing solution, distribute with a soft, wide brush, and keep the solution on the surface of the paper until the yellow lines become quite black. Thoroughly wash off and hang up to dry. It is the practice in many cases to plunge the print into a lead-lined bath containing a solution of gallic acid, and afterwards to remove it to the water bath for washing. *This extra bath is not necessary, and better results are obtained by using clean developer for each print.* The developing solution is prepared by dissolving ¾ oz. of gallic acid in boiling water. Sufficient cold water should be afterwards added to make up a gallon. This may be kept any length of time in a bucket or stone jar. It acts more rapidly when at a temperature of 70 deg. or 80 deg. F.

NEW TYPE OF EXPRESS LOCOMOTIVE, CONSTRUCTED BY MESSRS. HENSCHEL AND SONS, OF CASSEL.

"P.M." MONTHLY ILLUSTRATED NOTES.

A New Type of German Locomotive.

On Thursday, the 4th inst., a locomotive of a special type left the works of Messrs. Henschel and Sons, of Cassel, Germany, and is at present in the hands of the Cassel Railway Company for testing purposes.

The locomotive is to be used for the express service. It is constructed for a speed of 130 kilometres per hour, and develops, with a charge of 180 t. (4–5 four-axle carriages), about 1,400 h.p. The driving apparatus consists of three cylinders; the middle one of these, which actuates the first driving axle, receives the steam first, and the two other cylinders which are outside the frame actuate the second driving axle. Besides these two-coupled driving axles, the locomotive has also four running axles, two of which are in front and two behind.

The tender has also two double axles. All the axles of the locomotive and of the tender are provided with hand or air brakes, the power of which exceeds by two atmospheres the power of those in general use up to the present.

The locomotive and tender have a total length of wheel equal to 818 in., the length for the locomotive alone being 452 in. The distance between the front buffer of the locomotive to the end buffer of the tender is 977 in. As regards outward appearance, the locomotive and tender differ from those in use up to the present. They are entirely encased in a metal sheathing, which is pointed in the shape of a keel in the front of the locomotive, for the purpose of reducing the resistance of the air. By this arrangement, the builders hope to effect a saving of 250 h.p. to 300 h.p. The engine-driver's place is in a cab situated in front of the pointed part of the engine, from which place all the steering is done. There is also in the cab a second or assistant driver, who also assists the stoker in his work. For running the engine backwards, which is found necessary in railway stations, the assistant-driver looks after the brake and whistle at the back of the tender. From here and also from the stoker's place, verbal messages can be sent to the driver's cab. In order to facilitate communications on the engines, there are passages on the right and left within the steel sheathing. At the back of the tender there is the usual passage to the train, so that it is possible to keep up communications throughout the whole length of the train, from the engine-driver in the front part up to the guard at the end. The fire-grate of the locomotive is 4·2 square metres, and can burn 1,600 kilogrammes of coal per hour. The heating surface of the boiler is 257 square metres.

The tender carries 20 cubic metres of water, and can take 7 t. of coal. The weight of the fully equipped locomotive is 85,000 kilogrammes, and of the tender 58,000 kilogrammes. The charge on the axles never exceeds the regulation weight.

The locomotive was constructed entirely on the plans of Mr. Wittfeld, of the Berlin Ministry of Public Works, by Messrs. Henschel and Sons, of Cassel. After having been put to the test on the Cassel, Hanover and Berlin lines by the Prussian Railway authorities, this locomotive, together with two others of Messrs. Henschel and Sons, will be exhibited at St. Louis.

A Reconstructed and Enlarged Central Station.

An illustrated booklet recently issued by the British Westinghouse Company gives a detailed description of the power plant employed by the Meriden Electric Light Company, as reconstructed, and embraces several points of special interest to electrical engineers.

A feature of the plant is the system in use for separating the oil from condensed steam in order that the water may be again used in the boilers. The system embodies three main functions: mechanical oil separators in each engine exhaust, a vacuum trap, and filtration through oil-absorbent substances. Each engine exhaust pipe extends through the floor, and connects with the exhaust main through the 7-in. offset in which is located a De Rycke oil separator. These separators operate on the centrifugal principle, the current of steam during its discharge being thrown into rapid whirling motion by a set of spiral vanes. The entrained moisture and oil are thrown against the interior of the separator and gravitate to a pocket beneath, which is provided with a gauge glass for observing the depth of the liquid. The oil pockets are piped through valves to an oil main which discharges into a receiving tank. The tank is air-tight with a dished head and a large gauge glass. A discharge pipe leads from near the bottom of the tank to the brook.

The system is not automatic. The receiver tank has a capacity of 250 gallons and the present accumulation amounts to about 220 gallons of fluid per day. This consists of small quantities of heavy black oil, together with an emulsion having an approximate proportion of 1 to 50. A rectangular steel tank serves the double purpose of filter tank and hot well. It is approximately 3 ft. by 10 ft. by 5 ft., and is built of sheet steel properly re-enforced with angle iron. The filter compartment consists of a series of vertical baffles, each sliding inways for convenience of cleaning. Between the baffles sponges are packed and held down by wire gauze. The steam from the condenser is discharged into the first partition, pursuing a zig-zag course around the baffles to the hot well at the other end of the tank. Whatever oil escapes the separators is usually removed by the sponge filters, and the water is then pumped directly from the hot well into the boilers. At intervals of about a week the sponges are taken out and boiled to remove the collection of oil.

The Junior Institution of Engineers.

On June 14th about 120 members of the above Institution visited the motor-car works of Messrs. D. Napier and Sons, Acton Vale. A new type of motor has recently been introduced at these works, with 6 cylinders, cast in three parts, and mounted on an aluminium crank case. All work is finished to gauge. Motive power is obtained from an 80-h.p. Westinghouse 3-cylinder gas engine, and a 2-cylinder engine of the same make. At the conclusion of the inspection Mr. E. Eade, member of council, expressed the acknowledgment of the members to Messrs. Napier for the enjoyable evening which had been afforded.

Business and Professional.

Messrs. Lobnitz and Co., Ltd., Renfrew, are constructing a powerful gold dredger for the Société des Dragages Aurifères du Tinkisso.

The Canadian business of the Allis-Chalmers Company, which recently acquired the Bullock Electric Manufacturing Company, of Cincinnati, will hereafter be conducted by a new organisation bearing the name Allis-Chalmers-Bullock, Ltd. The works and principal offices of the new Canadian Company are in Montreal.

The Electricity Company which supplies the areas on the left bank of the Seine at Paris has decided to extend its generating station at Issy. Four Westinghouse alternators of 600 kilowatts each are to be installed in place of the former units, the latter being now too small to cope with the increased demand for energy.

The reports that appeared in some of the daily papers as to their recent fire having caused the impression that the Canning Town head premises of Messrs. J. H. Sankey and Son, Ltd., have been destroyed, they call attention to the fact that the glazed brick store at their L. and N.W. Railway depot only was burnt. The fire has not and will not affect the carrying out of contracts.

Mr. H. V. Croll, who has been in charge of the Salt Lake City, Utah, office of the Company for several years, and who was before that the representative of the E. P. Allis Company at Spokane, Washington, has been appointed to the charge of the Allis-Chalmers Office in San Francisco, as the successor of Mr. George Ames, who has resigned. Mr. Croll's San Francisco office is 623, Hayward Building.

Mr. James W. Lyons, who has been for many years associated with the same company in the capacity of engine salesman, has been appointed manager of their newly created power department, with headquarters in Chicago. This department will control the output of reciprocating steam engines, steam turbines (entire unit including turbo-generators), condensers, gas engines, pumping engines, blowing engines, hoisting engines, and air compressors.

Messrs. W. R. Renshaw and Co., Ltd., have in hand at the present time an order from the Great Western of Brazil Railway Company, Ltd., for fifty sets of ironwork (*i.e.*, wagons complete with the exception of the wooden bodies and wheels) for 12-ton 8-wheeled bogie wagons for shipment to Brazil. They are also completing twenty-eight gunpowder vans for the North British Railway Company, which are being constructed throughout to the latest requirements of the Railway Clearing House for this class of rolling stock.

Fourth New Midland Steamer.

The last of the four new steamers built for the Midland Railway Company has now been launched, and has been christened the *Manxman*. The new vessel has been built by Messrs. Vickers, Sons and Maxim. The other steamers built for the Company in connection with the Heysham Dock enterprise are the *Antrim*, built by Messrs. Brown, of Clydebank; the *Donegal*, by Messrs. Caird, of Greenock; and the *Londonderry*, by Messrs. Denny, of Dumbarton. The *Londonderry* and the *Manxman* will both be propelled with turbines, but in the one case they will be worked with an initial steam pressure of 150 lb. to the square inch, while in the *Manxman* steam will be supplied at 200 lb. pressure. It will, therefore, be possible to ascertain by actual experiment, whether the increased steam pressure with its attendant increase in the weight of the machinery, is a step in the right direction. The reversing turbines of the *Manxman*, which are fitted on the two side-shafts abaft of, and in the same casing as the low-pressure turbines, are more powerful than any that have been put into any previous ship, being capable of developing power equal to more than 50 per cent. of that available for going ahead. De Laval turbines are to be installed for driving dynamos, which will supply electricity not only for lighting the ship, but also for various power purposes, while the dynamos in the *Londonderry* are driven by Parsons turbines.

Machinery at the Royal Agricultural Show.

The number of exhibitors' stands in the implement and machinery department at the Royal Agricultural Show at Park Royal was the lowest for some years, and showed a falling off to the extent of 106 compared with the last exhibition. The section for machinery in motion fell to 2,060 ft., which is the lowest for more than a dozen years. Implements entered as "new," to obtain if possible the Society's silver medals, numbered 66, or 29 below last year's total. This section of the show, nevertheless, proved to be of considerable interest, and we shall deal with several prominent features in our next issue.

A Power Plant for Cape Colony.

Messrs. Mather and Platt, Ltd., have just been awarded by the Admiralty the complete contract for the whole of the plant to be erected at the dockyard, Simon's Bay, Cape Colony, for supplying electricity for lighting and power. This contract covers: (1) Two boilers of Babcock and Wilcox's make, each capable of evaporating 8,000 lb. of water per hour, and working at a pressure of 160 lb., together with feed pumps and all the piping; (2) Two steam dynamos, each set comprising a 2-crank compound double-acting engine by Browett-Lindley, direct coupled to a Mather and Platt 200-kilowatt multipolar shunt wound dynamo, to give this output at any pressure from 220 volts to 250 volts, and to carry 25 per cent. overload; (3) A surface condenser with steam-driven air pump and motor-driven circulating pump; (4) Overhead travelling crane; (5) Storage battery of 500 ampere hours capacity; (6) Booster for charging the above battery; (7) Two portable motor-generators to convert the 220-volt current to any pressure between 80 and 110 volts for use on ship circuits; (8) Switchboard with two dynamo panels, battery panel, motor panel, and 6-feeder panels, all mounted with necessary instruments, switches and fuses; (9) A large number of motors for the workshops, varying in power from 5 b.h.p. to 50 b.h.p. together with starters, all connections, testing instruments, etc.

A new 2-in. Centre Friction Geared Chucking Lathe with 4⅝-in. hole in Spindle.

We are indebted to Messrs. H. W. Ward and Co. for the accompanying illustration of a new lathe, which is a heavy tool suitable for all classes of chucking and bar work.

The bed is strong, wide and well ribbed; it has large bearing surfaces, square edges, and is supported on two box pedestals, and has a large oil pan so arranged as to collect the oil and strain it into a well underneath, to which the pump is connected.

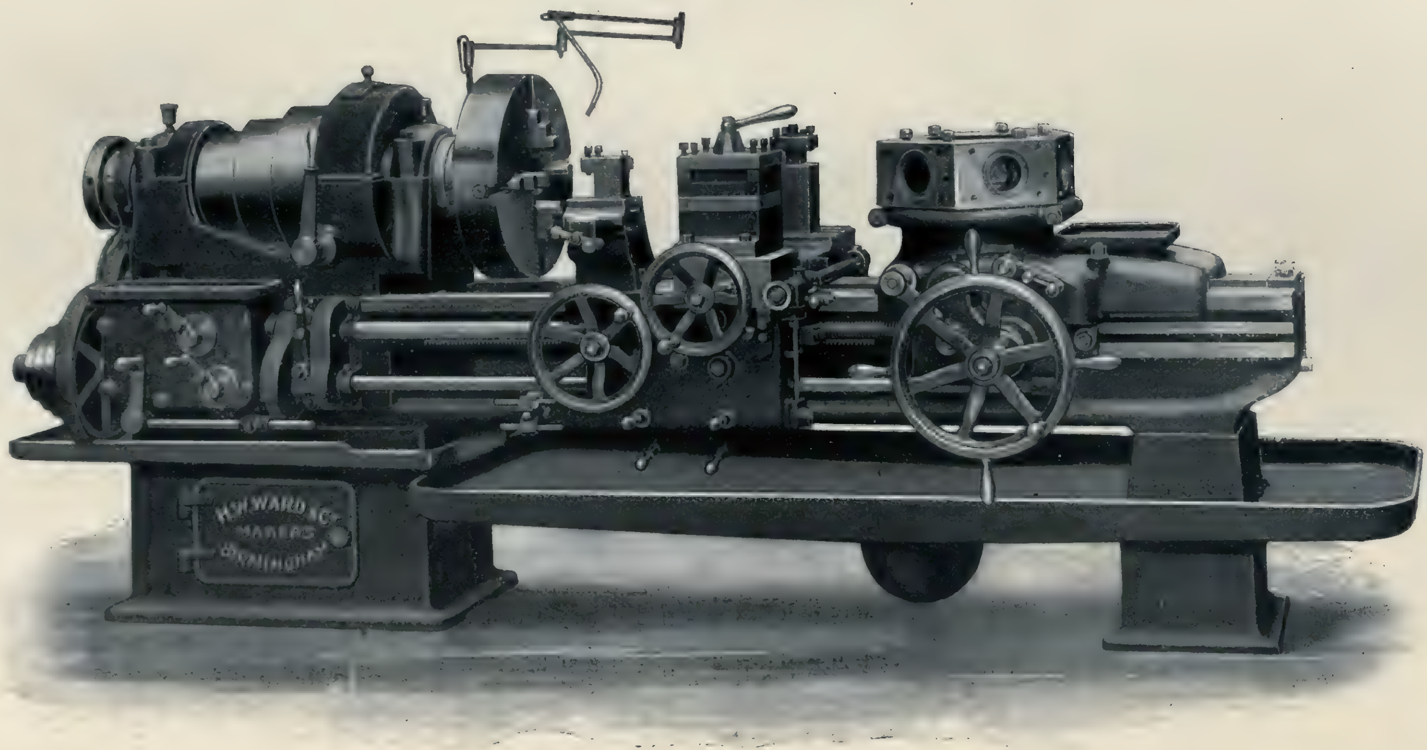
The headstock carries a spindle of hard steel, which runs in split parallel gun-metal bearings, arranged with caps to take up the wear and friction washers to take the thrust; the hole through the spindle is 4⅝ in. wide to allow of 4½-in. black bars being passed through. The driving cone has three speeds, and carries a belt 4½ in. wide, and the gear is of the power of 8 to 1, and being a friction drive may be thrown in or out whilst the machine is in motion by the lever in the front of the headstock.

The cross-slide has automatic sliding and surfacing feeds, and is also arranged for screw-cutting; the top slide carries on the front a square turret for four tools, and has an indexing arrangement for bringing the tools into position; on the back of the slide is an ordinary square tool-post to carry two tools.

The feed motion to cross-slide and saddle is taken from the tail end of the spindle by a train of spur gear to the change boxes under the headstock. These boxes contain eight changes and a reversing motion any of which may be instantly obtained whilst the machine is running by the use of the three levers on the front of the box. Four of these changes of motion communicate with leader hub, so that four different threads may be cut from the one hub, either right or left hand.

The turret is hexagonal in form, and is 15½ in. across the flats; it is carried on a strong saddle which slides on the bed and may be operated by either hand or feed. The turret revolves on a large bung and is indexed by a cylindrical bolt of large diameter, which is hardened and ground, and fits in locating bushes, which are also hardened and ground.

The bolt is withdrawn by lever when it is required to revolve the turret, and is returned to its place after revolving by a spring sufficiently strong to properly locate the turret, which is then firmly locked in position by a grip ring around the outside diameter of the turret.



MESSRS. H. W. WARD AND CO.'S LATEST LATHE.

The feed to the turret is driven by the three-speed cone at the tail end of the lathe, and two extra changes by gear are provided by moving the lever at the right hand of the change box; thus six feeds in all are available, for the turret and the gear is so arranged that the change is such as will be useful when boring and reamering.

The feed may be put in action from the front of the turret. Six stops are provided, one for each tool being used, and these are arranged in conjunction with a self-selecting arrangement under the turret, which ensures the correct stop being always in position, whether the turret is revolving backward or forward. There is a complete arrangement of oil pump and fittings. The countershaft has two pairs of fast and loose pulleys, 16 in. and 20 in. diameter, which, together with the cone pulley and gearing, gives twelve changes of feed to the spindle. The lathe will swing over bed $22\frac{1}{2}$ in. and over saddle 14 in. diameter. It takes between face of turret and chuck 4 ft. 6 in., and weighs approximately 4 tons.

Our Monthly Biographies.

NIKOLA TESLA AND HIS "WORLD TELEGRAPHY."

NIKOLA TESLA (whose portrait appears as the frontispiece of our present issue) was born at Smiljan, Austria, and was educated chiefly at Carlstadt. Electricity early attracted him, and while an engineering student at the Polytechnic School at Gratz he devoted all his spare time to that study. He was subsequently engaged in the engineering department of the telegraph at Buda Pesth, and in 1881 turned his attention to improving the construction of dynamos. From 1882 to 1884 he resided in Paris, acquiring experience with one of the leading electrical companies, and in 1884 took up residence in America, where he has brought out a number of inventions of great value to the electrical profession. Among these may be mentioned a system of arc lighting, a potential regulation of dynamos and motors (which in one modification is now known as the "third brush regulation"), a thermo-magnetic motor and generator, a double-disc dynamo, and various types of alternate-current motors. He has been latterly engaged in the study of alternating currents of high tension and high frequency.

When the "Electrical World and Engineer" celebrated its thirtieth birthday, Tesla contributed an interesting account of his researches, and described his magnifying transmitter, by the aid of which we are promised that the globe will be transformed. A Tesla central power plant and transmitting tower for "World Telegraphy" is being erected at Wardenclyffe, Long Island, N.Y.

Much, says Tesla, has already been done towards making my system commercially available, in the transmission of energy in small amounts for specific purposes, as well as on an industrial scale. The results attained by me have made my scheme of intelligence transmission, for which the name of "World Telegraphy" has been suggested, easily realisable. It involves the employment of a number of plants, all of which are capable of transmitting individualised signals to the uttermost confines of the earth. Each of them will be preferably located near some important centre of civilisation, and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket, may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horse-power can operate hundreds of millions of instruments, the system will have a virtually infinite working capacity, and it must needs immensely facilitate and cheapen the transmission of intelligence.

The first of these central plants would have been already completed had it not been for unforeseen delays which, fortunately, have nothing to do with its purely technical features. But this loss of time, while vexatious, may, after all, prove to be a blessing in disguise. The best design of which I knew has been adopted, and the transmitter will emit a wave complex of a total maximum activity of ten million horse-power, one per cent. of which is amply sufficient to "girdle the globe." This enormous rate of energy delivery, approximately twice that of the combined falls of Niagara, is obtainable only by the use of certain artifices, which I shall make known in due course.

Tesla states that one of the chief uses of his invention will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high-frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus.

Right Hon. Sir BERNHARD SAMUELSON, Bart., F.R.S.

SIR BERNHARD SAMUELSON, whose name is so widely known in connection with technical education and the development of the British iron industry, was born November 22nd, 1820. He was privately educated at Skerlaugh in Yorkshire, and commenced his business career in a mercantile office in Liverpool, subsequently gaining a great deal of useful experience on the Continent, where he had charge of some extensive contracts in locomotive work for Messrs. Sharp, Stewart and Co., of Manchester.

He returned to England at the age of twenty-seven, and laid the foundation of his fortune by purchasing some small implement works and a foundry at Banbury. In conjunction with Mr. John Vaughan he took an active part in the development of the Cleveland district. In 1853 a site was purchased at South Bank for the erection of three blast furnaces supplied with ironstone from the Eston Mines. These works were successfully carried on until 1863, when they passed into the hands of the late Mr. Thomas Vaughan, from whom they were acquired by Bobekon, Vaughan and Co., under whose ægis they now rank among the largest in the North of England.

Sir Bernhard Samuelson's next enterprise was the erection of four furnaces at Newport, near Middlesbrough, having an enlarged capacity of from 20,000 to 30,000 cubic feet, or nearly 3,000 ft. more than the next largest furnace at that time built in Cleveland. In 1870 the furnaces had increased to eight, very important economies being effected by larger capacity, increased temperature at the tuyères, and greater regularity in working consequent upon improved construction.

Photo by Lombardi and Co.]
RIGHT HON. SIR BERNHARD SAMUELSON, BART., F.R.S.

The Britannia Iron Works, Middlesbrough were commenced in 1870, many acres of what was originally a waste marsh being reclaimed by covering it with slag, and transformed into a manufacturing centre of first importance. At the present time these furnaces give employment not only to workers at Middlesbrough, but also indirectly to those engaged in the coal mines of Durham and the ironstone mines of Cleveland. These works, very much enlarged, are now the property of Durman, Long and Co., and at present turn out from 3,000 to 4,000 tons of steel, chiefly girders, per week.

Our space does not permit us to enter into the details of the experiments made by Sir Bernhard Samuelson for the manufacture of steel from Cleveland iron. Though unsuccessful and involving a loss of £25,000 or £30,000, they were the forerunners of what are now the Britannia Works.

Sir Bernhard Samuelson is the holder of the Telford medal of the Institution of Civil Engineers, this having been awarded to him for his essay on the construction of blast-furnaces.

When in 1867 the country was waking up to the need of technical education, Sir Bernhard Samuelson's knowledge of English industrial conditions and his Continental experience peculiarly fitted him to conduct a personal inquiry into the systems in vogue at home, and those employed in France, Belgium, Germany, and Switzerland. His report was published as a Parliamentary paper, and was for years referred to in all debates on technical education. He followed this up by a Parliamentary Inquiry into the education of the workmen of our manufactories in 1868. Sir Bernhard was chairman, and the report of the committee was adopted by the House of Commons. He was a member of the late Duke of Devonshire's Royal Commission on scientific instruction, which issued a valuable report, for which Sir Bernhard was responsible so far as it related to the Science and Art Department. The recommendations of this report were acted on by subsequent administrations, both Liberal and Conservative. He was a member also of the Royal Commission on Elementary Education, presided over by Viscount Cross, which reported in 1888. Sir Bernhard's greatest work on this subject was that of the Royal Commission on Technical Instruction, of which he was chairman. The work extended over the years 1882, 1883, and 1884, and embraced an examination into the systems in use in all parts of the United Kingdom and a great part of the Continent of Europe. It was on the successful conclusion of his labours on this Commission that Her late Majesty was pleased to create Mr. Samuelson a baronet of the United Kingdom. He was for several years Chairman of the Associated Chambers of Commerce of the United Kingdom.

He is a member of the Institute of Civil Engineers, Past-President of the Iron and Steel Institute, a member of the Cleveland Institution of Engineers, of the North of England Ironmasters' Association, and of the Middlesbrough Chamber of Commerce, and is at the present time President of the Cleveland Literary and Philosophical Society.

Sir Bernhard is a Fellow of the Royal Society, and holder of the medal of the Legion of Honour of France. He is a magistrate for the county of Oxford, and has twice been elected an alderman of the County Council of Oxfordshire. On his retirement from Parliament he was created a Privy Councillor,

SHIPBUILDING NOTES.

Shipbuilding and the A.S.E.

The second half of the shipbuilding year opens with considerably less promise, and with increased anxiety as to the profits of shipowners. The trade unions seem to be recognising that the bustle of present activity is more or less illusory. So, at least, one may judge from what Mr. G. N. Barnes, General Secretary of the Amalgamated Society of Engineers, says in his annual report. He states that last year was characterised by dull trade and decreased employment, the donation list reaching dimensions which, barring the period of the lock-out, had not been reached for some ten years. Wage reductions came into operation in Scotland, and on the North-East Coast, at Barrow, and at Belfast. These reductions, by negotiation with the Employers' Federation so far as England and Scotland was concerned, and with the Belfast shipbuilding firms for Ireland, were delayed and minimised, and, speaking generally, amounted to 1s. per week. The society was, however, convulsed by voting and counter-voting thereupon during the whole time, and although the recommendations of the Executive Council were ultimately given effect to, it was only after an irregular stoppage of work on the Clyde, followed by the rejection of three Councilmen whose term of office happened to terminate at the time, and who had offered themselves for re-election. These happenings, Mr. Barnes says, denoted an amount of unrest and dissatisfaction unprecedented in the society's history, and were fraught, he believes, with more than lay on the surface. In the main they denoted the violent clashing of two antagonistic principles—centralised authority and local autonomy. The first had been imposed upon them by modern conditions, and the second had been to many one of the prized features of the society, since its inauguration 53 years ago. How far it might be possible to harmonise these two ideas time alone could tell, but he re-affirmed his conviction that in all questions of trade policy there must be that unity of purpose and control which it was only possible to obtain from a common centre. Let that centre be as close as may be to the membership; let it be brought into contact with the actualities of the workshop, as well as with the larger actualities which surround it; let its proceedings even be brought under periodical and critical review; but safety to the society lies, he is convinced, only in yielding due respect to its recommendations and acquiescence in its decisions. Localism in this respect was indeed in their internal affairs but a form of that sectionalism which with one voice they descried when presented externally in the garb of small and ineffective organisation. The funds of the A.S.E. at the beginning of the year amounted to £546,367, and at the close to £602,425. The membership is now 95,403, an increase of 2,151 on the previous year.

Filipinos and the U.S.

The Collector of Customs at San Francisco recently levied head taxes, aggregating $212, on citizens of the Philippines who arrived on the s.s. *Korea*. The Pacific Steamship Company protested to the Department of Commerce and Labour, contending that citizens of the Philippines coming to the United States were not subject to head tax under the Immigration Laws, and Mr. Cortelyou asked the opinion of the Attorney-General on the point. Mr. Knox, in his opinion, states that section 33 of the Act of March 3rd seems to settle the matter. It provides "That for the purposes of this Act the words 'United States,' as used in the title as well as in the various sections of this Act, shall be construed to mean the United States and any waters, territory, or other place now subject to the jurisdiction thereof." In a note Mr. Knox adds: "Head tax is collectible 'at any port of the United States,' and this by virtue of section 33 includes a port of the Philippines. Perhaps, also it may be argued that a citizen of the Philippines is 'a citizen of the United States' within the meaning of the latter phrase in section 1. However this may be, we must give a reasonable interpretation to the laws, sometimes at variance with their language, and it seems incongruous to place the Philippines within the United States for the purpose of the Act, and the Filipinos among the taxed outsiders."

Cunard Competition.

Lord Inverclyde, of Glasgow, has written to the newspapers in regard to Continental emigrant traffic with America, and refers to the contract made by the Cunard Company with the Hungarian Government, which includes, among other things, the transportation of Hungarian passengers from the Hungarian port of Fiume to New York at a fixed rate per head. The bitterest opponents of this agreement, he states, have been the Norddeutscher-Lloyd and the Hamburg-American Packet Company, some of whose attacks upon it can only be justified by the maxim that everything is fair in commerce as in war. The reason of their opposition, no doubt, is that they have hitherto substantially monopolised the whole of the emigration from Russia and the northern provinces of Austria and Hungary, and they are reluctant to give up any part of it. These two companies were permitted by the German Government to establish control stations on the north-eastern and eastern frontiers of Germany

in connection with the various railway lines by which emigrants from the north-west and east of Europe to the United States and Canada cross Germany. At these control stations all emigrants from Russia, Austria, and Hungary are examined, and, if necessary, disinfected, before they are allowed to pass the frontier, and each must have a certificate of such examination before he can continue his journey. The practice of the German lines, however, is to refuse to disinfect the passenger, or give such a certificate unless the passenger has booked by their own or one of their allied lines, and they were not allowed to proceed on their journey. Lord Inverclyde concludes by saying that, seeing the freedom with which the steamers of the two German companies in question are allowed to come to British ports and take British passengers, although they do not conform to the British Board of Trade regulations, this stopping of Russian and Austrian passengers intended for British lines is indefensible and contrary to international usage. He also adds that this arbitrary action was developed and completed some time before the Cunard Company made its contract with the Hungarian Government for the transport of Hungarian emigration.

Canadian and Mexican Shipping.

Sir William Mulock, the Canadian Postmaster-General, recently visited Mexico with a view to arranging for a two cent, or penny, rate of postage between Canada and Mexico. President Diaz agreed to the proposed penny postage, and discussed with the Canadian Minister various ways and means of developing trade between the two countries. As a result of these interviews, President Diaz promised to send an accredited representative to Ottawa. This Mexican agent went to Ottawa for the purpose of discussing the establishment of direct steamship communication between Mexico and Canada. The proposal is to have sailings both on the Atlantic and the Pacific, monthly at first, and of greater frequency as the results warrant. In summer, the vessels trading on the Atlantic will start from Montreal, calling at Quebec, St. John, and Halifax on their way to Mexico. On the Pacific coast the service will be so arranged as to give an opportunity to all localities which have anything to export that is saleable in Mexico. It is expected that Canadian coal, lumber, fish, and flour can be shipped at a good profit by both the Atlantic and the Pacific liners, and agricultural produce, bacon, and a certain proportion of Canadian manufactures will find a place in the cargoes. The Mexican Government is satisfied that Mexico can supply in return many articles that now only reach Canada through the United States at a comparatively exorbitant price, and others that it has not hitherto been profitable to send as far as Canada on account of the heavy charges for rail transportation. By the direct steamship service, these Mexican products can be landed in Canada at a figure which will almost immediately lead to a large trade. It is intended that the proposed Atlantic and Pacific steamship services will be heavily subsidised by both the Canadian and Mexican Governments. Canada is bent on acquiring new markets by the establishment of direct steamship communication. She now has direct lines with Great Britain, France, Germany, South Africa, Australia, the West Indies, China and Japan. Negotiations are also on foot for a line to Italy, as well as the proposed Mexican service.

Panama Canal and U.S. Trade.

A report by the French Consul-General at New Orleans, on the probable disturbance in the lines at present followed by the commerce of the United States which will result from the construction of the Panama Canal, is worth some notice. The conclusion drawn from the evidence collected is that a great part of the trade passing through the Canal will enter and leave the United States by way of the ports situated on the Gulf of Mexico; and that while it is unsafe to prophesy any actual falling off in the prosperity of New York and the other Atlantic coast ports, a great stimulus will be given to the trade of the Gulf ports—New Orleans, Galveston, etc. It is pointed out that New Orleans is 600 miles nearer to Colon, at the entrance to the Canal, than is New York, while many of the Central States of the Union, west of a line from Chicago to Charleston, are nearer to New Orleans than to New York. It is, however, impossible to forecast exactly the effect on trade of the opening of the Panama Canal. Some authorities believe that the prevalent idea of the revolution which will be effected among existing trade routes is greatly exaggerated. Thus, the inter-trading relations of Europe, Asia, Africa, and Australia are not likely to be greatly affected, since the Suez Canal already affords a route from Europe to the East, which is shorter than the Panama route for all connections except those with the ports of New Zealand, Japan, and North China. A geographical fact which is less generally recognised is that the voyage from New York to Hong Kong is practically the same length eastwards through the Suez Canal as it will be westwards through the Panama Canal. West of Hong Kong the advantage in point of distance will lie with the Suez route; east of Hong Kong the Panama route will have the advantage. It has been estimated that in voyages from New York to ports between Singapore and Shanghai the preference for one route over the other will depend on the amount of the Canal tolls. So far as the commerce of the United States is concerned, if New Orleans becomes the great clearing-house for goods passing through the Canal, the advantage of distance will rest with the Panama route to a greater extent. The Panama Canal will command a certain proportion of the trade between Europe and the western shores of North and South America, as well as of the coasting trade between the Atlantic and Pacific coasts of the New World. The conclusions of the French Consul-General are interesting as an attempt to elucidate the new conditions which will govern competition for, at least, a part of the trade of the world, but the matter merits wider consideration than can be given in these notes.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, June 22nd, 1904.

The Institution of Electrical Engineers.

At the annual meeting of the Institution of Electrical Engineers it was shown that no less than 668 names had been added to the register during the year. The annual report makes special recognition of the services of Mr. R. K. Gray during the interval between the death of Mr. McMillan and the appointment of the new secretary, Mr. G. C. Lloyd. Mr. Gray may be said to have stepped into the breach at a critical time, and was thus to a large extent responsible for the uninterrupted continuity of the work of management. Among other questions dealt with in the report was the need for a more exact definition of the qualifications required for Associates of the Institution. Mr. Alexander Siemens will assume office as President at the first ordinary general meeting of the session, 1904–5.

The Forthcoming Visit to America.

The members of the party of the Institution who are going over to the United States for the forthcoming Electrical Congress, are to sail from Liverpool on August 25th, by the White Star liner *Republic*. The estimated cost, including first-class fares and ordinary hotel expenses, with a contribution towards the expenses of the Institution will be about £80, but this does not include incidental expenses. The Electrical Congress Reception Committee is making elaborate preparations to welcome and entertain the party, which will be taken in charge throughout by the American Institute of Electrical Engineers. At every stopping place Ladies' Reception Committees are also being formed. At the present time it is expected that the party will number about 80 in all. The President of the Institution, Mr. R. K. Gray, will meet the party at Boston.

The last International Electrical Congress was held in 1900, in conjunction with the Universal Exposition at Paris. The last preceding International Electrical Congress in the United States was held in 1893, in connection with the World's Fair at Chicago. Electrical Congresses held in the past have certainly had an important influence on the world's progress in the knowledge of electricity and magnetism, and in the applicaton of these sciences, and it is confidently expected that the International Exposition of 1904, at St. Louis, will be equally successful in these directions.

The date set for the International Electrical Congress at St. Louis is the week September 12th to 17th, 1904 (inclusive). This is the week preceding the session of the great Scientific Congress appointed by the Universal Exposition. On this account many of those who attend the International Electrical Congress will probably remain to attend the International Congress of the Arts and Sciences. In accordance with the present plan, members arriving *via* New York will be enabled to reach St. Louis *via* Niagara Falls on Sunday September 11th. Members will also be invited to attend the dedication ceremonies of the National Bureau of Standards at Washington. It is hoped that arrangements may be completed whereby the President of the United States may then meet the members. On the

morning of September 12th, at 11 a.m., a general convocation of the International Electrical Congress will be called. On the four succeeding days, from the 13th to the 16th inclusive, meetings of the eight sections of the Congress will be held simultaneously. On the final day, September 17th, a second general convocation will be called. Members returning from St. Louis to New York may elect to stop at Chicago and at Niagara Falls.

Features of the Congress.

As at present proposed, the International Electrical Congress will comprise three distinct features :—

(1) A Chamber of Delegates, appointed by the various Governments, and essentially similar to the Chambers of Government Delegates at the International Electrical Congresses of Chicago in 1893, and of Paris in 1900. It would seem that sufficient material has been collected since 1900, calling for International action, to warrant inviting the various Governments to appoint Delegates, as before, to the International Electrical Congress of St. Louis.

(2) The main body of the Congress is divided into the following sections: General Theory, Section A, Mathematical, Experimental. Applications : Section B, General Applications ; Section C, Electrochemistry ; Section D, Electric Power Transmission ; Section E, Electric Light and Distribution ; Section F, Electric Transportation ; Section G, Electric Communication ; Section H, Electrotherapeutics. It is proposed to invite prominent men in various parts of the world to contribute special papers on subjects represented in the various sections and their sub-divisions.

(3) Conventions simultaneously held, in connection with the Congress, by various electrical organisations in the United States. It is proposed that each section of the Congress may be able to hold its meeting under some plan of conjunction with the organisation or organisations devoted to the progress of the work selected by that section. Steps have already been taken to enlist the sympathy of the various organisations, with a view to perfecting the details of co-operation at a later date. Prominent among the organisations from whom co-operation is expected are—The American Institute of Electrical Engineers, the American Electrochemical Society, the National Electric Light Association, the Association of Edison Illuminating Companies, the Pacific Coast Transmission Association, and the American Electrotherapeutic Association. It is also hoped to secure the participation of American scientific societies.

The Universal Exposition of St. Louis has signified its intention of affording ample facilities for the accommodation of the Congress in its halls on the grounds of the Exposition.

The International Catalogue of Scientific Literature.

The International Council, which is responsible for the International Catalogue of Scientific Literature, has decided to continue the work under the direction of Dr. H. Foster Morley beyond the five years for which guarantees were originally given. The seventeen volumes, comprising the first annual issue, were completed in February last, while nine of the volumes of the second annual issue have been already published. The volumes vary in price according to size from 10s. to 39s. The Catalogue deals with publications issued since 1901, and is published under the auspices of the Royal Society. It is designed to publish by means of an International organisation, a complete catalogue of scientific literature arranged by subject matter, and also by author, thus enabling scientific investigators to find out easily what has been published concerning any particular subject of inquiry. It takes cognisance of original matter in periodicals, proceedings, independent pamphlets, memoirs or books, and receive its information through regional bureaus established in twenty-five different countries. The regulations provide for the inclusion of technical matters of scientific interest, under the appropriate scientific headings. Among the seventeen subjects dealt with are mathematics, mechanics, physics, chemistry, mineralogy and geology.

The first issue of the catalogue has practically paid its expenses! At the same time it should be understood that it is not being run as a commercial enterprise but for the benefit of scientific investigators. Any profits that may ultimately accrue will be devoted to the improvement of the catalogue. At the present time Dr. Morley is the responsible custodian of some 600,000 scientific reference slips.

The Mineral Wealth of Peru.

A propos of Mr. Schafer's article, last month we quote the following from the "Society of Arts Journal" :—

In Peru, the main production of silver and copper is obtained at Cerro de Pasco. For several centuries this famous mineral centre overflowed the world with its silver, although the working of the mines was merely superficial, and the system of amalgamation entirely deficient. The depth of the mines very seldom exceeds 150 ft. It is only in recent times that the existence of copper in enormous quantities was discovered at Cerro de Pasco, which has become one of the largest deposits of copper in the world. In the case of gold it is rather difficult to estimate the annual production, as the mine owners do not issue any complete statistics. The mercury or quicksilver of Huancavelica will, it is stated in a recent report by the United States Vice-Consul at Callao, become, in the near future, a rival of the famous mines of Almaden in Spain, and of New Almaden in California. The exploitation of iron is at present of no great importance in Peru. A considerable quantity of this metal is found at Tambogrande (Piura); also in the provinces of Colca and Larez. It also exists in various other parts of the country, but no serious attention appears to have been given to the matter as yet. The principal port of the department at Piura is Paita, and it is said that ironworks established there could easily provide all the Pacific coast with as much iron and steel material as at present is drawn from the United States and Europe. The lead mines have not been worked, up to the present, with any profit, but there is said to be an opening here for persons with capital and well provided with up-to-date machinery to lessen the cost of production. Sulphur exists in good abundance in all the volcanoes of the Andes, and it presents itself in such dense layers that it is difficult to estimate the quantity that might be extracted, or form an idea of the thickness. It also occurs extensively near the sea, on the Peninsular of Aguja, near Paita. Many varieties of coal are produced in Peru, but as no records are kept, it is not possible to state the exact amount yielded in the country. From a carefully prepared estimate, however, for a recent year, the amount appears to be about 55,000 tons. Salt is widely distributed in different parts of Peru, although the principal salt pits are on the coast, and are easily and cheaply worked. Owing to the dry atmosphere of the Peruvian coast, different classes

of salt have accumulated as well as nitrate. The importation of salt in Peru is absolutely prohibited. The whole coast of the Department of Piura produces petroleum, and that is the only part of Peru in which it is worked.

Another Locked-up Country.

Another country which is more or less locked up pending the realisation of railway enterprise is the Soudan. The Berber-Suakim Railway is, however, being pushed forward with all speed, and, according to Mr. Leigh Hunt, who is taking up a large tract of land for cotton-growing experiments, it will be the key to the whole country. In the course of an interview, Mr. Leigh Hunt said he had travelled in most parts of the world, but nowhere had he witnessed such unparalleled progress as in the Soudan. "One cannot now speak of exploration in the Soudan, for the Sirdar's officers had left nothing to explore. The marvellous results of Lord Cromer's policy, so ably executed by Sir Reginald Wingate, are to be met with in the most remote parts of the Soudan, and even among the interesting and in many cases still naked tribes. We passed among these people with perfect safety, and were always treated with the greatest courtesy and respect. The possibilities of the Soudan from an agricultural standpoint for the growing of cotton, wheat, and fruit are very great." By the way, it is interesting to note that Sir William Willcocks estimates that the works necessary to give Egypt perennial irrigation and flood protection will cost £8,200,000, spread over a period of twenty-five years.

Power-Gas from Peat.

During his recent tour in the United States, Mr. B. H. Thwaite, C.E., read before the New England Cotton Manufacturers' Association an interesting paper on gas-power applied to the textile industry. In the course of this he mentioned that years ago he had carried out a series of experiments in making power-gas with Irish peat. The peat was fed into the author's cupola generator, the gas produced was introduced into a gas-engine and acted perfectly, the indicator diagram of power was very little different from that obtained with poor coal.

The author's investigations into the question of generating motive power by direct combustion commenced after 1889. In his investigations almost every available fuel was employed, ranging from wood, charcoal, peat or bog fuel, coke, coal, both anthracite and hydrocarbonaceous, and he found that all these fuels are available for producing motive-power-gas.

The result of the author's work and especially that associated with the harnessing of the waste gases from blast furnaces to gas engines, had been the elevation of the gas engine, high and over possible competition, by the steam engine, whether rotative or reciprocating.

The remarkable success attending the employment of the waste gases with their 90–110th British heat units of thermal value per cubic foot was immediately followed by an increase in the power units of internal combustion engines, and to-day single-unit quadruple-cylinder engines of 3,000 i.h.p. were available for the power user. One of the main issues of the author's investigations was the fact that by the physical compression of the explosive mixture, a combustible gas of almost any thermal value above 50 British heat units per cubic foot could be employed in a gas engine.

The author realised that if the density of the poor combustible gas was increased by physical compression to a certain degree, the sluggish inflammability of the gas would disappear, and the gas and air would ignite with sufficient rapidity and certainty of effect to satisfy internal combustion engine working requirements.

This fact, once demonstrated, brought into the field of future service, the enormous volumes of waste gases that flow into and pollute the atmosphere at every iron-making centre, and in the United States alone, the potential of power of the furnace gas from the American furnaces was counted in hundreds of thousands of horse-power.

To meet the demand for engines to convert the awful waste of power, many eminent engineers on the Continent of Europe had for several years been applying almost their entire attention in designing engines to secure all the qualifications that a steam user and electric supply consumer must have, and in Germany alone it was said that over 50,000 h.p. of large capacity gas engines were in active service.

Ironmasters were under a great obligation to the textile manufacturers for the enterprise that had been devoted to securing the most economic steam-power instrument, and to-day the finest examples of land steam engines were still to be found in textile mills.

Sea Commerce and War.

Attention may be drawn here to an article in the new naval annual, by Mr. Carlyon Bellairs, on Commerce and War. As he says, "A strong navy is to Britain a complete defence; a weak navy is no defence at all." What is wanted for the defence of our empire and the protection of our commerce is a sufficient number of battleships to deal successfully with thoss of our opponents, and an adequate supply of cruisere to act as scouts, look-outs, and for the purpose of lying off certain ports of refitment to which commerce-destroyers may resort. The fact that this country is dependent on oversea supplies of food and raw material is fully recognised by our rivals, who believe that by launching some fast cruisers, or torpedo boats, on the highways of the ocean it would be possible to starve Great Britain, to suppress her commerce, and to ruin her industries. The Royal Commission, which is now considering the food supplies of the country in time of war, have to endeavour to solve the problem by means of co-operation between the Government and private enterprise. One of the points to which Mr. Bellairs refers has reference to the prospects of the best steam coal mines in South Wales. If we knew the destination to which this coal is sent each week in the year we should then be ready to intercept, or to buy it up, on the prospect of war. In this case, co-operation between the Government, the mine-owners, and the middlemen is needed. Another point is whether the supply of shipping to carry cargoes in war is likely to be in excess of the demand. As to this, information must be obtained from Lloyd's and the various Harbour Trusts of the United Kingdom. Again, some idea should be obtained about the shipping entered and cleared with cargoes and in ballast, and also the vessels entered and cleared with cargoes only. The Navigation Returns issued by the Board of Trade do not give the necessary details, but they could easily be got and should be supplied in the future. The lesson which Mr. Bellairs tries to drive home in his article is that attacks on commerce are only efficacious when based on the successful action of fleets, and that it is the duty of those responsible for the defence of this country and its mercantile marine to see that our navy is kept equal to all the demands that may be made upon it. It is only, as he points out, by working steadily at such problems in times of peace that we can hope to be prepared for emergencies in time of war.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY N. I. D.

GREAT BRITAIN.

AN important circular affecting the engineering branch of the Navy was sent out by the Admiralty at the end of May. By the provisions of this circular a certain number of private students are to be entered at the Royal Naval Engineering College, Keyham, without being under any obligation to enter the Naval service at the end of the course. The fees will be £75 a year, and while under training the students will be subject to the same conditions of discipline, uniform, pay, and leave as the ordinary cadets. In the event of there being vacancies also, they will be eligible for commissions in the Navy under the same conditions as engineer cadets.

Rumour has been very busy with the *Lord Nelson* class, as indeed was only to be expected. To the details which I was able to give last month, however there is not very much to add. Their coal capacity is now reported to be sufficient to give them a radius of 7,000 miles, that is to say, a maximum of about 2,000 tons, which is that of the Duncan class on a displacement of 14,000 tons.

Meantime, the vessels already in hand are being pushed on as rapidly as possible, and since advance plans of the *Lord Nelsons* have been sent to Devonport, it seems possible that these vessels, as well as those of last year's programme, will be dockyard built. The *Britannia*, at Portsmouth, is expected to be ready for launching early next December. The *Commonwealth* has begun her trials on the Clyde, but no particulars are available at the time of writing. The *Hindustan* is still at John Brown's, and is progressing rapidly.

It has been decided that the *Triumph* and *Swiftsure* shall spend their first commission in home waters, and on June 21st they were commissioned by Captains C. Burney and E. J. Fleet, respectively, for service with the Home Fleet. The *Triumph* replaces the *Empress of India*, and the *Swiftsure* the *Resolution*.

The *Prince of Wales* was commissioned at Sheerness on May 18th, and left, all her inspections and her commissioning trials satisfactorily completed, within 54 hours. This is very good work, and deserves to be put on record.

The *Duke of Edinburgh* was launched at Pembroke on June 14th. Lady Cawdor performed the naming ceremony, and the launch was a complete success. Work on the *Warrior* is also being pushed forward, and she may take the water before the end of this year.

The only important commissioning in the armoured cruiser class is that of the *Suffolk* at Portsmouth.

Turning to the smaller vesssels, we find that the *Topaze* has undergone most of her trials, and that considerable doubt has been expressed in some quarters as to the real value of the "scouts." The "Times" devoted a long article to the subject recently, and the defects of the class were mercilessly exposed. The speed is considered too low, and the bunker capacity too limited for vessels which are really destroyers of destroyers, and while to get five knots extra speed and a thousand tons coal capacity (which is what most critics recommend) would necessitate the building of larger vessels, with greater displacement, it is contended that the consequent gain in efficiency would more than outweigh any possible disadvantages.

Of torpedo craft, the two Yarrow destroyers *Ribble* and *Welland* have completed their trials. Full details are not to hand at the time of writing, but it is announced that both contract speed and horse-power were easily attained, and the coal consumption was comparatively low. Destroyers are now tried along the new measured mile off Dover, the comparatively low depth of water off the Maplin Sands tending to lower the speed of the vessels. The *Kennet*, building by Thornycroft, is also reported as ready to leave the contractor's works, and is to join the Medway Fleet Reserve "A" Division until required for service. The *Waveney* has also been delivered at Sheerness.

Submarine *A 1* has now gone to Barrow again to be refitted. Her machinery and batteries were seriously damaged by the lengthened submersion, and they had to be removed before the vessel was towed north.

Before leaving Great Britain, I must mention that the new Admiralty yacht *Enchantress* has been completed and commissioned.

FRANCE.

The French Navy Estimates for this year total 310,000,000 fr. (£12,400,000). Of this sum 68,000,000 francs (£2,720,000) are to be devoted to the building and completion of ironclads, a circumstance which M. Pelletan very much deplores. He asks Parliament to devote at least 23,000,000 francs (£920,000) to the construction of small craft.

Only one new armoured cruiser is, however, included in the building programme for 1905. She is to be of the *Renan* type, and is known at present as *C 17*. She is to be built at Lorient, according to present arrangements. Four torpedo-boat destroyers of the *Stylet* class, of 28 knots speed, are also to be put in hand at Rochefort. For twenty torpedo-boats the plans are not yet complete. With regard to submarine-boats only very slight information is obtainable. At present there are twenty-three under construction, *Omega* at Toulon, *Emeraud*, *Opale*, and *Rubis* at Cherbourg, and *Saphir*, *Topaze*, and *Turquoise* at Toulon. These last six vessels were all commenced in October, 1903. They displace 422 tons, and are to have an indicated horse-power of 600. *Q 47*—*Q 62* are not yet laid down, while sixteen more, of the programme of 1904, are to be built, four at Cherbourg and twelve at Toulon. The programme for 1905 allows for eight more submarines, three to be built at Toulon, three at Cherbourg, and two in Rochefort.

During 1905 there will be in all 95 vessels under construction for the French Navy, six battleships the *République* (to be commissioned during 1905), *Democratie*, *Patrie*, *Liberté*, *Justice*, and *Vérité*; four armoured cruisers, *Jules Michelet*, *Victor Hugo*, *Ernest Renan*, and *C 16* (*C 17* being apparently indefinitely postponed); eight torpedo-boat destroyers—*Stylet*, *Tromblon*, *Pierrier*, *Obusier*, *Mortier*, *M 38* and *M 39*, to be built in the public yards, and *Claymore* in a private establishment; fifty-five torpedo boats, ten to be built in public and the others in private yards, and the twenty-three submarines above mentioned.

New regulations for the trials of vessels have been promulgated, and the first vessel to profit by them is the *Condé*. The tests are now arranged as follows: (1) Coal consumption trials of six hours' duration, with fires lighted under half the boilers; (2) two machinery trials, one of ten hours at full speed, and the other of three hours at the highest speed obtainable with three-quarters of the boilers in use; and (3) a run of twenty-four hours at ordinary speed. The time between the trials is not to exceed three days.

except under special circumstances, which must be reported to the Minister of Marine.

On her full speed trials the *Conde* attained a speed of 21·35 knots, with a maximum horse-power of 22,800. The coal consumption was about 35·23 lb. per square foot of grate surface. On the twenty-four hours' trial she did 18·6 knots with engines developing 11,000 h.p., the coal consumption working out at 1·63 lb. per unit of power per hour. The whole of the trials were carried out in seven days, whereas under the old regulations they might have lasted weeks and even months.

The only other trial worth noting is that of the torpedo-boat destroyer *Balliste*. On a coal consumption trial, at a speed of 18 knots, she burnt fuel at the rate of 2·34 lb. per unit of power per hour.

GERMANY.

As I foreshadowed in my notes for May, the new scheme for naval expansion which has been brewing in German official circles for some time past, is rapidly coming to a head. From Berlin advices, thrown out perhaps semi-officially as feelers, it appears that this new scheme altogether surpasses the programme of 1900. No fewer than twenty battleships and ten armoured cruisers, together with attendant small craft, are said to be in contemplation. Germany is poorly supplied with torpedo craft, and the new programme is expected to make liberal provision for this class of vessel, to the extent even of 6,925,000 marks (£346,250). Submarines are also to receive more attention than has hitherto been the case.

The *Lothringen* battleship, was launched on May 27th, at the Schichau Yard, Dantzic. The *Lothringen* was built ready for launching in exactly one year, and her launch leaves only one battleship now on the stocks, "N," which is building at Kiel. The boilers of the *Lothringen* are a combination of eight Schultz and six cylindrical boilers, and with engines developing 16,000 h,.p. and driving three screws. She is expected to attain a speed of 18 knots. Her other characteristics are similar to those of the other vessels of the *Braunschweig* class, already described in these notes.

The *Berlin*, protected cruiser, is expected to be ready for service next April, by which time the *Hamburg* should also be complete. At her full speed trials recently, the *Hamburg* developed under a forced draught 11,582 h.p., giving her a speed of 23·15 knots. On a mean of four runs over the measured mile, the results were 11,889 i.h.p., 145 revolutions, and 22.54 knots.

The active list of the German Navy for 1904 is composed of 1,139 officers, ranking as follows: 5 admirals of the fleet, 7 vice-admirals, 17 rear-admirals, 6 post-captains, 136 captains, 273 commanders, 394 lieutenant-commanders, 245 lieutenants. There are also 470 sub-lieutenants, and 151 naval cadets.

RUSSIA.

Reports from various sources state the Russian Naval programme for 1905 includes the construction of eight new battleships of the *Imperator Pavel I.* type, and several armoured cruisers of the *Bayan* class. This report comes from both German and Italian sources, but the German report states that some of the vessels are to be built in France, a rumour which is in direct contradiction of the Imperial *ukase* ordering all Russian war vessels to be built for the future in Russian yards. One of the armoured cruisers it is reported will be paid for by public subscription, and named the *Admiral Makharoff*.

Three new torpedo-boat destroyers, the *Totschnii*, *Twjordii*, and *Trewoshnii*, have been laid down at Creighton's Yard, and are to be completed with all despatch.

The Holland Torpedo Boat Company, of New York, is stated to have received an order from the Russian Imperial Government to build and complete five submarines within eight months. Five others are believed to have been ordered from Vickers, Sons and Maxim, to be completed in the same space of time.

ITALY.

The new battleship *Regeina Elena* was launched at Spezia on June 19th, in the presence of the King of Italy. Preparations are also being made for the launching of the *Vittario Emanuele* at Castellamare about the middle of August. The *Roma*, building at Naples, should be ready to take the water about the middle of November, and the *Napoli* should leave the slips at Spezia some time early in 1905.

The Italian Naval Estimates for 1904–05 amount to £5,087,643, which is £343 in excess of the estimates for the previous financial year. The amount apportioned to new construction is £1,533,469. This sum is to be devoted to the completion of the armoured cruiser *Francesco Ferrucio*, the further construction of the battleships *Regina Elena*, *Vittorio Emanuele*, *Roma*, and *Napoli*, and the commencement of a new armoured cruiser at Castellamare, three submarines at Venice, and fourteen torpedo boats. The two destroyers *Teffiro* and *Espero* are to be completed also.

The new armoured cruiser is to be the first of a class of seven of 10,000 tons. It is also reported that the construction of fourteen torpedo-boat destroyers and forty torpedo boats is in contemplation, but that it has been deferred until next year.

UNITED STATES.

The first keel plate of the new battleship *Vermont* was laid at the works of the Fore River Comqany, on May 20th and the work will be pushed forward as rapidly as possible.

The armour plates of the new battleship *Georgia* have been tested, with satisfactory results.

The *Louisiana*, which is building at the Newport News Company's yard, is now nearly ten per cent. more advanced than her sister the *Connecticut*, and it seems likely that the Navy Yard will be beaten in the race for the completion of these two vessels.

The *Ohio* is the battleship nearest to completion. Of the three large vessels of last year's programme, the *Minnesota* is fifteen per cent. in advance of the others, and the two smaller vessels, the *Mississippi* and *Idaho*, at Cramp's Yard, are not very well advanced.

In armoured cruisers, the *West Virginia*, *Pennsylvania*, *Colorado*, and *Maryland* are most advanced. The *Tennessee* and *Washington* are making good progress.

MINOR NAVIES.

HOLLAND.—The battleship *Hertog Hendrik*; of the *Konigin Regentes* type, was launched on March 22nd, and the *Tromp*, of the same class, on June 15th. The displacement of these vessels is 4,950 tons, length 312 ft., beam 48 ft. With 6,000 h.p. they are to steam 16 knots, the boilers being of the Yarrow type. The principal armament consists of two 9·4 in. guns, and four 5·9 in. quick-firers.

There is a submarine building for the Dutch Navy at Flushing.

ERRATUM.—In last month's issue the trials of the gunboat *Widgeon* were referred to as being carried out by Messrs. Thornycroft. This, of course, was a slip of the pen. H.M.S. *Widgeon* having been built by Messrs. Yarrow and Co., Ltd.

THE CIVIL ENGINEER AT WORK.

By C. H.

The Institution of Civil Engineers.

The annual Conversazione of the Instituti onof Civil Engineers was held as usual at the Institution Building, Great George Street, a large number of guests being received by Sir W. H. White (President) and Lady White. Numerous models and exhibits of engineering apparatus were on view, prominence being given to models of Japanese and other warships. Sir William White exhibited a model of the Bermuda floating dock. Mr. Francis Fox gave an exhibition of views illustrating the Zambesi Falls and vicinity, and Sir Fortescue Flannery contributed a pictorial review of the progress of naval construction. Photographs illustrating the difficulties encountered in the construction of the Simplon Tunnel also proved of great interest.

International Engineering Congress.

I have received a prospectus of the International Engineering Congress, to be held under the auspices of the American Society of Civil Engineers, in conjunction with the St. Louis Exhibition, commencing October 3rd, 1904 :—

The Congress will be one of the series of International Scientific Congresses to be held at the Exposition under the general authority and with the co-operation of the Director of Congresses. Its object is to secure a thorough International consideration of certain branches of engineering work which have been selected with special reference to their present interest and importance. In order to facilitate the work of the Congress and to insure the presentation of topics in a systematic manner, the Committee has prepared the subjoined tentative list of the subjects which have been selected for review and discussion :—

Harbours, natural waterways, artificial waterways, lighthouses, and other aids to navigation, traffic on improved waterways, as compared with seaboard traffic, and the effect of this development on railroad traffic ; purification of water—(*a*) for domestic use, (*b*) for the production of steam ; turbines and water wheels, irrigation, railroad terminals—(*a*) at ports, (*b*) inland ; underground railways, locomotives and other rolling stock, live loads for railroad bridges, the substitution of electricity for steam as a motive power, sewage disposal, disposal of municipal refuse, ventilation of tunnels, highway construction, concrete and concrete-steel construction, deep foundations, the manufacture of steel, tests of materials of construction, passenger elevators, pumping machinery, dredges—their construction and performance ; steam turbines, electrical power—(*a*) generating stations, (*b*) transmission ; naval architecture, marine engineering, dry docks, ordnance, fortifications, mining—(*a*) surveying, (*b*) hoisting, (*c*) ventilation ; engineering education, gas engines, surveying, ocean hydrography, wharves and piers.

A Model Dock Scheme.

In his remarkably complete treatise on the Principles and Practice of Dock Engineering,* lately issued from the press, Mr. Brysson Cunningham, B.E., describes an ideal dock scheme on the *digital* plan. The suggestion emanated, in the first instance, from the late Thomas Stevenson, but the design in the figure embodies several important modifications of the original sketch, and includes an entrance which has not, to the author's knowledge, appeared elsewhere. The idea is that the dock is situated on the margin of a tidal river, or estuary, and the dual entrance, as explained in Chapter VI., is intended to permit of the dock being accessible at all stages of the tide. When the flow is up the river, vessels will enter by the up-stream locks and depart by the downstream locks. *Vice versâ,* when the tide is running out, incoming vessels will use the downstream locks, and those departing, the upstream locks. In this way the dock will be worked without intermission and without obstruction. It is assumed that the outer sills are deep enough to allow vessels to pass over them at low water.

The scheme has been amplified so as to include all the features essential to a dock scheme. Graving docks of various sizes are arranged between the entrance locks, with ample intermediate space for ship-repairing depôts. In order to have shoreward connection for these, it will be necessary for the locks to be spanned by movable bridges.

The central portion of the dock is semi-circular in form, and designed to afford turning room for vessels

* A Treatise on the Principles and Practice of Dock Engineering, by Brysson Cunningham, B.E., M.Inst.C.E. With 34 folding plates, and 468 illustrations in the text. —Charles Griffin and Co., Ltd. 30s. net.

up to 1,000 ft. in length. There are also four utilisable berths, each 275 ft. long.

The branches, of which there are five, though irregular in form, are all similar, and each provides quay accommodation in pairs of lengths of 1,000, 600 and 400 ft. successively, together with an end berth of 350 ft. The indentations permit of ships overlapping, while at the same time berths are afforded for small craft of 100 to 120 ft. in length. A further advantage of the indentations is that moored vessels are well recessed out of the way of those passing in and out of the branches; in fact, provision is made for vessels being attended in their berths by rows of lighters on each side without obstructing the main waterway.

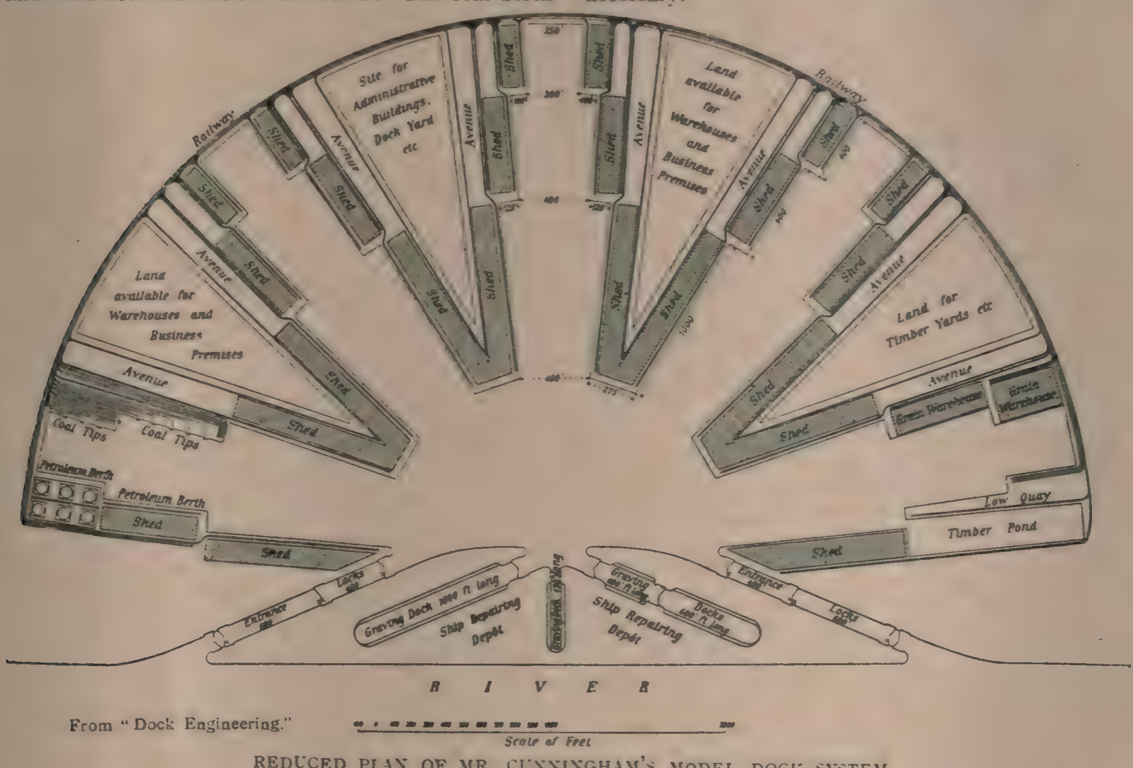
Commercial Adjuncts.

The sides of the branches, generally, are lined with sheds, from 100 to 120 ft. in width, of varying lengths, and of heights taken at two storeys, but capable of adjustment to circumstances. The sheds are recessed 40 ft. from the edge of the quay, to allow of lines for quay cranes and railway trucks. These lines, as well as others at the rear of the sheds, are all in intercommunication by means of a circular railway along the landward boundary of the estate, which is supposed to be connected with trunk lines leading to other towns.

Special berths are provided at one branch dock for petroleum and coal, and at another for grain and timber. The petroleum berth has both tank storage and shed accommodation for barrels. The coal berth consists of an open quay, laid with numerous sidings and furnished with projecting jetties for hoists and tips. Grain is received direct into warehouses, the face line of which is within five feet of the edge of the coping. Timber may be discharged into a single storey shed, or on to a low quay, or it may be floated into the timber pond. The river frontage is also available for timber storage, as well as for a cattle wharf, if required, with a lairage at the rear.

There are four surplus plots of land, triangular in shape, between the branches. These can be utilised as sites, partly for administrative buildings and offices, and partly for warehouses and goods depots, timber yards, and the like commercial adjuncts of a dock system. The land immediately adjoining the entrance locks will be advantageously occupied by the dock-master's office and residence, and by dwellings for dock gatemen and other officials, whose constant attendance upon the spot is desirable. A convenient site will also be found in the vicinity of the graving docks for a pumping station, and, if hydraulic power is to be employed, for one or more accumulators, though possibly the requisite power may be as readily obtained from an external source, such as the mains of a private company or of a municipal body.

The design is an ideal one in this respect, that it pre-supposes an entire freedom of action in regard to site and outlay which is rarely attainable. There is nothing, however, to prevent the carrying out of the scheme partially, or in instalments, as may be found necessary.



From "Dock Engineering."

REDUCED PLAN OF MR. CUNNINGHAM'S MODEL DOCK SYSTEM.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Electricity in Mines Report.

The Electricity in Mines Report has now been issued, and there can be no doubt that the members of the Committee have been thoroughly impressed with the large part that electric power is going to play in mining. They state that if installed with insufficient skill or handled carelessly accidents must occur, but they see no reason why, if properly set up, and used, there would be such danger as would justify prohibition. Referring to the hewing of coal by hand, it is recognised that the danger from the coal falling on to the miners would largely disappear if coal cutters were used, as in the majority of cases it would be only the machine that would be damaged. On account of more systematic tunnelling which the use of coal cutters involves, the number of falls would be much reduced. Amongst other collieries which the Committee visited, was that of Pope and Pearsons, where they were shown an electric coal cutter driven by a 3-phase motor, which was undercutting 250 tons of coal per day, the holing being 6 ft. wide.

Reading between the lines of the Report, the balance of evidence appears to have been in favour of alternating as against continuous current. Colliery managers are warned against studying an immediate saving in capital cost without at the same time keeping before them the prospect of a long bill for renewals and repairs which will almost inevitably follow.

Overhead Transmission of Power Lines.

The present attitude of the Government towards overhead transmission of power wires is most encouraging to those who have always maintained that this country is handicapped by the existing regulations. The technical advisers to the Board of Trade have expressed themselves as favourable to the employment of bare wires in suitable situations, and as the Board is the deciding body in case of dispute between the Local Authorities and a Power Supply Company, we shall soon have high tension overhead lines. It is probable that the Board will require that the wires shall be at least 28 ft. from the ground, and the poles fixed at such a distance from the road that if a pole falls towards the road the wire will be clear of the path. Where the wires go over a road, a guard wire netting will be necessary, similar to those used on the Continent.

The Proved Reliability of Overhead Transmission.

Regarding the general reliability of overhead transmission, two particular cases may be cited. One is the historic transmission from Tivoli to Rome, a distance of 19 miles, at 20,000 volts. This has now been in operation for over 13 years, supplying the whole of the energy required for the lighting power and tramways in the City of Rome, and no accident or breakdown has been reported. The other is the case of Buffalo, which is supplied from Niagara Falls, through two pole lines, one 20 miles and the other 23 miles long, the voltage being 22,000. Even so long ago as 1901, the Buffalo load consisted of 7,000 h.p. in tramway motors, 4,000 h.p. in large three-phase motors, and 4,000 h.p. for arc and incandescent lighting.

Probably the most telling argument as to the general reliability of overhead wires is the fact that of the total mileage of wire used for electrical purposes in the United States, only 6½ per cent. is underground.

It may be suggested that there would be risk of breakdown where the supply is carried along a single pole line. However this may be, it is nevertheless a fact that some of the longest transmissions in the world are through single pole lines; amongst them being—

Electra to San Francisco, 154 miles, 60,000 volts;
Santa Ano to Los Angeles, 83 miles;
Shawinigan Falls to Montreal, 85 miles.

Lightning Arresters for Transmission of Power Lines.

Experience in countries where lightning storms are very much more frequent than they are in this country has shown that the likelihood of an overhead transmission line being struck, is very remote. In any case, such lines are protected by means of Siemens and Halske's arresters of the flaring-horn type, placed on the poles at intervals. One side of each arrester is permanently connected to a good earth, and they do not require any adjustment, as the arc following a lightning flash is automatically suppressed by reason of the air convection, currents of air causing the arc to rise up the spreading horns, and also because the current passing between the horns acts as a single turn magnetic blowout and repels the arc up the horns. These lightning arresters are universally employed for transmission lines all over the world, and have been found to meet all ordinary requirements.

Another method of protection is by means of the water squirt arrester, as employed at Vizzola Power Station in Northern Italy. In this apparatus, several jets of water are caused to continually play on to the live wires. In case of a lightning flash travelling along the line as far as the Power Station, it immediately goes to earth down the jets of water. The minute distances between the small drops of water, however, effectually prevents current from the electric generators following the lightning. A feature of this apparatus is that it is always ready, and there is nothing to burn out, as is the case where metal is employed.

Sleet and Ice on Overhead Wires.

When telegraph or telephone wires are torn down it is usually caused by sleet or ice forming on the wire, and not only increasing its weight but also offering a greater surface for wind pressure. The reason why accidents on power transmission wires are so low is apparently traceable to the fact that a power wire is much larger. It is not worth while erecting wires much less than $\frac{3}{16}$ in. diameter and 0·324 in. diameter (No. 0 B & S.) is the size usually employed. A second reason is that the current passing through the wire keeps its temperature appreciably higher than the surrounding atmosphere. In a telegraph or telephone wire the current is very small, and further it is intermittent. In a power transmission, on the other hand, current is always flowing, and in case the demand is considered to be too low to keep sleet or snow from freezing on the wires, it is an easy matter to increase the current temporarily by means of resistances.

POWER STATION NOTES.

By E. K. S.

Erosion of Buckets of Tangential Water Wheels.

One of the troubles met with in water power plants is the sand and other solid matter in the water. A stream which comes from a glacier or a mountain lake is the best in this respect, as the water is usually free from sand. When sand, etc., is present in any quantity, a surface reservoir has generally to be constructed to allow the solid particles to settle. In any case, if sand is present it does less harm on a Pelton wheel than it would on a turbine, for when the erosion of the buckets is sufficiently advanced, it is only a matter of an hour or so to fix a new set. The buckets are always made with a simple fastening, so that they can be changed with very little trouble by unskilled men. Sometimes the water is charged with a material which has greater eroding action than sand. For example, at the Burma Ruby Mines the water contains large quantities of ruby dust, with the result that the buckets on the Pelton wheels, as well as the nozzles, have to be renewed about once every three months.

Lining of the Tail Race.

Under high heads of 1,000 ft. or so, after the water has left the wheel it still has considerable velocity, and as the lining of the tail-race is liable to suffer, it is usual to line it just below the wheel with renewable elmwood planking, or with thick cast-iron plates. In the San Joaquin Power House in California, cast-iron plates are used. One reason for these renewable linings is that most tangential or Pelton wheels are governed by deflection of the nozzle, and therefore at times some of the water will strike the tail race with maximum nozzle velocity.

On the Snowdon Power Station, on the design of which the writer has been working, the head of water from Lake Llydow down to the power station (6,500 ft.) is 1,150 ft., which gives a pressure of 500 lb. per square inch at the nozzles of the (1,500 h.p.) tangential wheels. At the Pikes Peak Hydro Electric Company's Power Station, the enormous head of 2,100 ft., equal to 910 lb., is employed.

Lancashire Boilers with Multiwater Tubes.

The increasing use of water-tube boilers during recent years has without doubt affected the output of the Lancashire and other older types, and one result has been to give an incentive to the introduction of improvements. When the Galloway tube was first employed in Lancashire boilers the improvement in output and efficiency was most marked, and indeed in time these tubes came to be looked upon as standard practice. Seeing that they were such a decided improvement, it is somewhat strange that the makers have not before now taken a lesson from the water-tube boiler, and replaced their Galloway tubes by nests of smaller tubes, so as to still further increase the circulation and heating surface. It is interesting to note that this idea has now been taken up by the Premier Boiler Tubes, Ltd. A Lancashire boiler measuring, say, 30 ft. by 7 ft., and having two flues, each 2 ft. 9 in. in diameter, will ordinarily have ten Galloway tubes, and the areas will be—grate 33 sq. ft., flues and boiler shell 833 sq. ft., Galloway tubes 50 ft. sq. Now if the ten Galloway tubes are replaced by 144 (Premier) tubes, each about 3 in. inside diameter, the tube heating surface is increased from 50 sq. ft. to 330 sq. ft.

Tests made by Messrs. Nunsey, Leatherbarrow, Ashbury, Lancaster, and others show that the fitting of a 30 ft. by 7 ft. Lancashire boiler with 144 Premier tubes in place of Galloway tubes gave nearly 11 lb. of water evaporated per pound of coal, as against 7·16 lb. before the boiler was altered; the coal consumption per square foot of grate area, and also the draught were increased. One interesting feature in connection with this very practical improvement is that it can be applied to any existing boiler. The Galloway tubes are removed, and rectangular spaces cut in the top and bottom of the flue, over which stepped plates are rivetted, the tubes being then expanded into them. The nests of tubes are of course placed in groups alternately to right and left in the flue, in the same way as a Galloway tube, the groups being placed so as to leave ample room for a man to pass through the flue for inspection and cleaning. It may be asked whether these smaller tubes are not more likely to be scaled, but so far it has been proved not to be the case, owing to the extremely rapid circulation through them. In any case it is now generally recognised that the question of scale ought to be dealt with in the proper manner by softening the water before it enters the boiler, either by passing it through a feed heater if "temporary hard" or through a specially designed water softener if it has "permanent hardness."

Large Gas-driven Prime Movers.

As power requirements increase, both makers and buyers of gas engines are met by the same difficulties as in large steam engines, namely, their unwieldiness and great expense. The gas engine will no doubt pass through the same stages as the steam engine, namely, there will be the present period of slow-speed gas engines, then a period of quick-speed gas engines, and finally the gas turbine, the only point in which the development will differ from steam practice being that the steps will follow each other very rapidly. The quick-speed gas engine has, indeed, made its appearance in the Westinghouse engine, and attempts at gas turbines have already been made at Leeds. It is significant that a quick-speed steam-engine maker, such as Mr. Reavell, is hard at work on the gas turbine problem.

Gas Producers.

We understand that the 800 h.p. gas producer for the Willans gas engines at McMurray's Royal Paper Mills as mentioned in our May issue, is being supplied by the Power-Gas Corporation, Limited. This firm have now a gas producer plant of 1,000 h.p. capacity in operation at Messrs. James Cropper and Co.'s Paper Mills, Kendal, and a plant of 1,000 h.p. capacity is in course of construction for the London Paper Mills, Dartford. It is interesting to hear that there is so much activity in large gas engine work.

IRON AND STEEL NOTES.

BY

E. H. B.

An Ideal Foundry.

A work which should prove popular among those engaged in the iron-founding and allied industries has just been produced by Professor Thomas Turner, of Birmingham University. It is entitled "Lectures on Iron Founding," and is based upon a special course of evening lectures in connection with the School of Metallurgy of the University, delivered to practical workers engaged in the district. The author first discusses the general character and composition of the metal employed by the iron-founder. He deals with the arrangement of the iron-foundry, with the work conducted therein, and with some of the most important problems which the founder has to encounter. Discussing the features which go to make up an ideal foundry, he remarks that it should be a large well-lighted building, rectangular in plan, erected on a level site, close to railway and water communication, and with plenty of room around the building for sidings, stores, light, air, or future extensions. The buildings should be constructed so as to be well ventilated in summer, and warmed in the depth of winter. The working floor is of earth, but sufficient tram-lines should be provided to allow of ready transport of heavy material. One or more large overhead traversing cranes should be provided, and also a number of smaller jib cranes, so as to allow of the ready handling of heavy moulds and castings. Lastly, due attention should be paid to the sanitary arrangements for the convenience of the men, and these should include facilities for washing, and for some change of clothes, so that the moulders when they leave work may be able to do so with self-respect, and be in a fit state to travel in a public conveyance.

Machine Moulding.

The author remarks that in foundries where a large number of "repeat" orders, or orders of one kind, have to be executed, machine moulding is now very commonly applied, and is steadily growing in favour, particularly in America. Moulding machines are only used for the production of green sand castings, and in such machines it is, of course, necessary to use flasks and patterns as usual, but the machine largely reduces the labour, and increases the uniformity, when work of the same class is being continually turned out. Moulding machines cannot be used for intricate shapes or re-entering angles, but are especially suitable for work of a simple character which allows of the patterns being mounted on a board; or, where the pattern can be divided into two parts and mounted, either on two sides of one board, as in one class of machine, or on two separate boards, as in another form of machine.

Moulding machines answer admirably with patterns which are shallow, or when a number of small patterns can be grouped on one plate, when the mould is easy to ram, and when the rammed part can be easily withdrawn. In some cases patterns have to be withdrawn with a special motion or at an angle. For such work machine moulding is unsuitable, as the machine will only lift vertically. Work having a good deal of detail, provided it is shallow, can be readily done with a moulding machine, as can also cylindrical sections. On the other hand, castings of great depth and intricacy, or those with middle parts, cannot be so successfully done with machines as by hand.

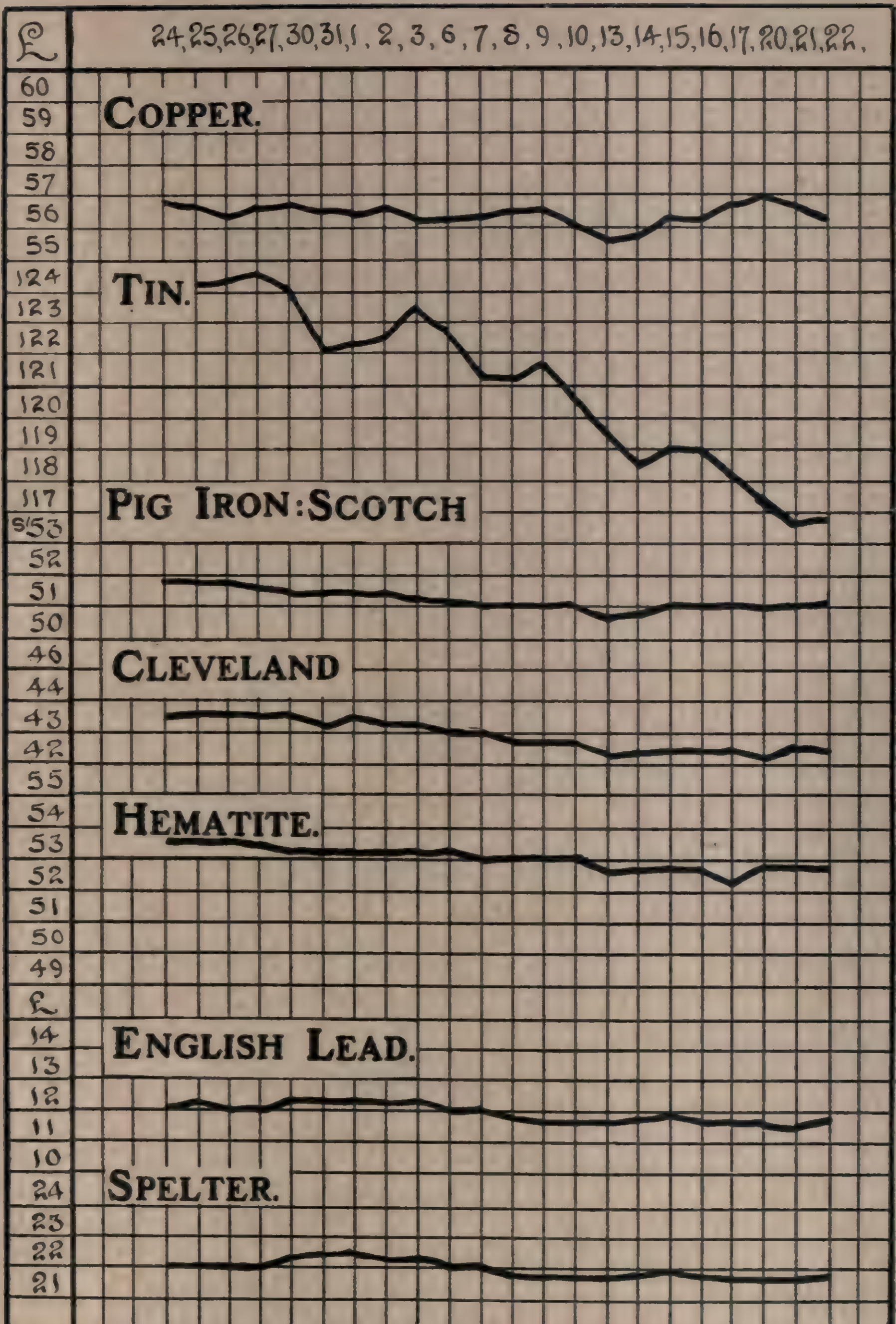
Incidentally, the author discusses in a practical manner common troubles of the iron founder such as shut ends, rough surfaces, blow-holes, sponginess, etc., and there is a valuable concluding lecture on tests for cast iron.

"Lectures on Iron Founding." By Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C., Professor of Metallurgy in the University of Birmingham. With folding plate and 52 illustrations. C. Griffin and Co.

High-Speed Steel.

Mr. A. Leggett, in the course of a paper on high-speed steels, read at a meeting of the Ipswich Engineering Society, says that as regards his own observations and experience with the steel, there are several points in its favour, apart from its efficiency or cutting powers. (1) It is easy to forge; (2) There is very little probability of spoiling it, although improper handling soon causes deterioration in the quality of the steel. Taylor White gives the so-called critical temperature of the steel at approx. 1,550, or a bright cherry-red colour. This is rather an important point in the making of the tool. Steel makers do not tell us that their steel deteriorates at a certain temperature, but some of them, in their instructions for forging and tempering, say that the tool should be soaked in the fire to a dull red, and then brought up to a bright white heat as quickly as possible. This is what is called the critical temperature; and, according to Taylor White's specification, that deterioration takes place rapidly between the temperatures shown. An analysis of the steel after being heated, he says, "showed that approx. ⅘ of the carbide of chromium or molybdenum and tungsten had been extracted or lost."

The author remarks that the cutting angles of the tool have a great influence upon its efficiency, and to obtain the best results the angle must be chosen to suit the work in hand. To obtain an approximate constant efficiency on various diameters, the angles must be made to suit. As a rough and general rule, the more acute the top side rake the less the resistance. The less front clearance the longer the life of the tool, for with excess of clearance there is nothing to back up the cutting point, so that vibration sets up, and the tool soon falls down from the series of shocks. The set of the tool—that is, the position in the rest—also has a very marked effect on the efficiency of the tool in the way of relieving the friction caused by the chip passing over the tool, and it is possible to make a considerable difference in the amount of metal removed by slightly altering the set. The tool is generally doing its maximum with the minimum amount of power when the chip is curling to a fairly large radius—that is, about 2 in. or 3 in. when turning from 5 in. to 6 in. diameter material. When the chip is curled up very close a great deal of power is wasted in simply curling the chip.



THE HOME METAL MARKET.

Chart showing daily fluctuations between May 24th and June 22nd.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

Lack of Uniformity and Finality in Locomotive Practice.

It is not a little curious how persistently Fate seems to interpose obstacles to uniformity or finality in locomotive practice. A few years ago outside cylinders were apparently doomed in this country, and—adopting the drivers' usual pronunciation—so were all locomotive boilers to be. When Mr. Adams retired from the London and South-Western, the last advocate of outside cylinders disappeared from the chief mechanical engineership of any leading British line, while Mr. J. Stirling's retirement from the South-Eastern similarly removed the sole supporter of the domeless boiler who yet survived in locomotive "high places." Thus all seemed to make for uniformity of British practice. All our engines were to have domed boilers—all inside cylinders. We had reached finality on two points, as to one of which—the steam-dome—we had previously differed, in the case of some of our railways, from all the rest of the world, while as to the other—the cylinder positon—we had all America and a majority of Europe against our former method. There appeared, therefore, a coming into line with the rest of the world, in respect of the latter point, but an accentuation of our dissent in the other particular through our own peculiar plan becoming universal in these islands. Yet in less than half a decade all this is changed. Once more outside cylinders have come to the front, and strangely enough this is the case more especially on some of the railways whose locomotive chiefs are the most emphatic in their preference for inside cylinders. The obvious explanation of this is that the outside position has been forced upon its opponents against their will through the combined exigencies of traffic-increase and loading-gauge dimensional limits. Still the fact is none the less remarkable and instructive.

Inside and Outside Cylinders.

In no case is this more prominent than in that of the Great Western. From its earliest days that railway has consistently adhered to the inside position for the cylinders of its locomotives. Alike in broad-gauge and in standard-gauge times, under Sir D. Gooch, Mr. Armstrong, Mr. Dean and Mr. Churchward this was the rule. The few exceptions were so *very* few as not to be worth mentioning. Yet suddenly the Great Western broke out into outside cylinders in the exceptional case of No. 100, and now it would appear as if this plan were henceforward to rule supreme. The London and South-Western, it is true, still remains faithful to inside cylinders, which Mr. Adams had latterly adopted in the case of all but the express engines, and which Mr. Drummond has extended to those also; but even among *his* London and South-Western builds there may be found six locomotives which have outside cylinders, although with inside ones as well. The London, Brighton and South Coast, and the South-Eastern and Chatham have always preferred the inside position, and still do. The Great Eastern, formerly an "outsider," has been an "insider" during the successive reigns of Messrs. Worsdell and Holden, yet the latter eminent engineer has felt constrained to build one engine which has a pair of outside cylinders as well as a single one inside—his famous "Decapod." The Great Northern, another staunch "insider," had yet to submit to outside cylinders in the case of Mr. P. Stirling's 8-ft. single-wheelers, because that wheel-diameter combined with a 28-in. piston-stroke rendered the other position impracticable. And now under Mr. H. A. Ivatt—another notable "insider"—the Great Northern has adopted outside cylinders for its standard express engines—the Atlantic Class. The London and North-Western was equally "inside-ish" save for Mr. Ramsbottom's 7-ft. 6-in. single-wheelers, until compounding compelled Mr. Webb to place his high-pressure cylinders outside the frames, while the Midland admitted among its own designs no exception to the outside rule until Mr. Johnson went in for the compound type, but then he too had to place a pair of cylinders—the low-pressure ones in his case—outside. So also on the North-Eastern "inside-ism" was practically all-prevalent until Mr. Wilson Worsdell brought out his six-coupled bogie express types, both of which had outside cylinders, as also have his new "Atlantics" and his eight-coupled goods engines as well. Similarly the Great Central, under Mr. Robinson, has turned to outside cylinders for its newest locomotive types, not only the "Atlantics" and six-coupled bogie expresses, but also the ten-wheeled mixed traffic or "fish" engines. On the Lancashire and Yorkshire, North British and Caledonian, Messrs. Hoy, Reid and M'Intosh have remained "insiders," but the Glasgow and South-Western and the Highland have adopted "outside-ism" in the latest designs of Messrs. Manson and P. Drummond respectively. Here then we have an apparent tendency toward uniformity, but oddly enough in a direction diametrically opposite to that which a very few years ago seemed virtually assured.

Other Divergent Methods.

As regards the steam dome, the Great Western remains the sole British railway which now ceases to supply it to newly designed locomotives. I have explained in former notes the reasons which influence Mr. Churchward in dispensing with it. Experience alone can test the wisdom or unwisdom of this plan in the adoption of which, at present, he stands virtually alone among the locomotive designers of the world. His distinction will be all the greater should time justify his departure from the normal. But at least it may already be said with confidence that the work

of his domeless engines is equal to that of any other locomotives of the same classes in the United Kingdom ; I prefer to content myself at present with this cautious predication—I will not attempt prediction. But much more remains to be said on this subject and probably may be said in the not-distant future.

Coupled Engines *versus* Single-Wheelers.

But the Twentieth Century really did seem to have brought us finality as regarded the long-vexed question of coupled *versus* single-driving wheels for express engines. Not one single-driver engine has been built in the whole civilised world—so far as I am aware—since the first year of the Twentieth Century. Nor are any more yet contemplated to my knowledge. But it is undeniable that the amazing performance of one single-wheeler on the Great Western Railway as chronicled in my notes for June, has "given pause" to those who were prepared to deem that type obsolete at last. It was no surprise to any locomotive engineer to find a 7-ft. 8-in. single-wheeler capable of very fast work with a light train on an easy road, but few people, if any, were quite prepared for so remarkable a display of such high-speed so long sustained as that which Mr. Dean's engine, No. 3065 "Duke of Connaught," achieved on May 9th, with a load of 120 tons behind her tender, on a road which afforded little, if any, aid from gravitation. That performance has revived the old question whether it may not be advisable, or indeed necessary, to limit the train-loads and increase the fares when extra high average speeds are required, as is done both in Europe and in America, and to employ single-wheelers on such services, which is *not* done either in Europe or in America. The attempt to haul the biggest modern loads at the highest modern average speeds is not yet an invariable success, and it may fairly be considered whether future accelerations may not necessarily be confined to new limited trains like the Brighton Company's Pullman on Sundays or the French "Sud Express" or the American "Twentieth Century Limited." I am referring of course to such suggested average speeds as 60 to 70 miles an hour or upward—which the Great Western record proved to be quite feasible—while the existing expresses booked at 50 to 60 miles an hour carrying all classes and weighing 300 to 400 tons, would not be interfered with. The idea seems worthy of careful consideration.

The New London and North-Western Locomotives.

Three engines of the fine and handsome eight-wheeled type recently brought out on the London and North-Western Railway by its new Chief Mechanical Engineer, Mr. G. Whale, are now at work, viz., No. 513 "Precursor," No. 1395 "Harbinger" and No. 1419 "Tamerlane." I have described the type in former notes, and it will be remembered that they have 6-ft. 9-in. driving wheels four-coupled, with inside cylinders 19 in. by 26 in., and large boilers with 2,009 square feet of heating surface. I may point out, in passing, that Mr. Whale thus reverts to *inside* cylinders, the traditional method of that railway. These engines, unassisted, are hauling loads for which a pilot was always employed when any previous London and North-Western locomotive was the train engine. To mention two cases which recently came under my own observation: No. 1395 "Harbinger" hauled from Euston to Crewe a train reckoned as "22 coaches" in exactly three hours, thus averaging 52·7 miles an hour from start to stop, in spite of 2 minutes delay caused by a special permanent-way slack of considerable duration just north of Rugby. There were three twelve-wheeled dining-cars, each computed as two coaches; ten eight-wheelers, each taken as 1½ ; and one six-wheeler. The twelve-wheelers were officially stated to weigh 42 tons apiece ; the eight-wheelers to average 26 tons each, and the six-wheeler 15 tons. Here, then, we have a total *tare* weight of no less than 401 tons, and if we include passengers, baggage, staff and stores, the total weight behind the tender cannot certainly have been under 420 tons. Further, if the delay be deducted from the travelling time, the average start-to-stop speed was 53·3 miles an hour. Now was a load of 420 tons behind the tender ever before hauled in Britain at an average rate of 53·3 miles an hour from start-to-stop over even so moderately-graded a road as the London and North-Western ? I am inclined to doubt it. And the minimum speed up the Tring bank, 1 in 330, never fell below 48 miles an hour with that load, or below 50 miles an hour up the 7 miles at 1 in 350 past Roade. Yet even that fine performance represented a loss of 3 minutes in the actual running from Euston to Crewe, because the booked average speed was 54·2 miles an hour. The moral would seem to be that such booked speeds with such loads cannot be relied upon with confidence. In the opposite direction No. 1419 "Tamerlane," of the same class, hauled from Crewe to Euston a train reckoned as "18 coaches," or 339 tons empty, 360 tons loaded, behind the tender, in 2 hours 50 minutes 43 seconds, *i.e.*, 4 minutes 17 seconds under booked time, and averaged 54·8 miles an hour. This is very admirable work.

The Latest Great Western Novelty.

Mr. Churchward's latest departure at Swindon is to bring out a fresh type of express engine, in which the 18-in. by 30-in. outside cylinders, which he has given to several new classes of locomotives, six-coupled bogie expresses, consolidation goods and heavy tanks, are applied to his standard "City" type. That is to say, he retains the 6-ft. 8-in. driving wheels four-coupled, the same wagon-top boiler, and Belpaire firebox and 18 in. cylinder diameter. But he lengthens the piston stroke by 4 in., viz., to 30 in., and he does away with the double framing, giving the new engines single inside frames and outside cylinders. The new engines will be known as the "County" class and will be named after the various British counties. The pioneer, "County of Middlesex," is already out.

AUTOMOBILE NOTES.

By J. W.

The Side-Slip Competition.

The report of the Side-Slip Committee states that the recent side-slip trials produced thirteen entries. Three were devices forming an integral part of the tyre; three were discs in contact with the road carried on arms attached to the back axle; two were steel blades kept in contact with the road by springs and attached to the wheels, three to each wheel; three were detachable leather covers fitted with steel studs or segments; and two were detachable chains or plates.

The trials began with an endurance test of 857 miles, to which all the devices were submitted, except those which could be put in or out of action from the driver's seat; these latter were only run over a distance of 104 miles. The roads chosen were as far as possible representative, but included a large proportion of tram lines and setts. Observers were carried on all the cars throughout the whole of the endurance test, who reported every repair and renewal made during the runs. At the conclusion of the endurance test the cars were submitted to a trial of the absorption of power of the various devices. The cars were run down a hill at a speed of about 20 miles an hour, first with the device fitted, and secondly with the device removed. The distance between the stopping points under the two conditions was then measured, and it was shown that there was an appreciable difference in the power absorbed by the different devices.

The devices were then submitted to the actual side-slipping test. A space of 50 ft. by 10 ft. of smooth asphalt under cover was coated with a thin layer of Thames mud and fluid soft soap, forming a greasy substance closely resembling a London asphalt street on a damp foggy day. All the cars were required to cross the greasy patch at speed, and to attempt to make a sharp turn while on the grease. None of the cars succeeded in turning in the least degree out of the straight, all making a front wheel side slip in the direction of the length of the car, with the wheels locked hard over, clearly proving the necessity for having both front and back wheels fitted with a non-slipping device to ensure a perfect control under extreme conditions. The cars were then run over the greasy patch and the brakes applied suddenly; a considerable variation was apparent in the adhesion of the wheels fitted with the various devices. The cars were then made to start on the greasy patch and the results agreed with those of the brake test.

Awards.

Three of the devices under trial were then fitted to the front wheels, and this enabled the cars to make a fairly sharp turn on the grease. All the tyres, tubes, and devices were then examined for wear, and the results of the examination have been duly taken into consideration in framing the following recommendations: Prize of £150 and gold medal to M. L'Empereur for his device No. 12; second prize of £100 and silver medal to the Parsons Non-Skid Company for their device No. 14; third prize of £50 and silver medal to the Civil Service Motor and Cycle Agency for their billet device No. 15. Silver medal and high commendation to the Wilkinson Tyre and Tread Company for their device No. 8, and to Mr. Mark Vivian for his device No. 7. Silver medal to Mr. H. S. H. Cavendish for his device No. 2.*

* The various devices will be found scheduled in the May issue, on page 465.

Although the Committee have recommended the award of three money prizes with medals, and three other medals, they do not consider that any of the devices as entered for the competition met all the requirements. The problem is a difficult one, but more has been done towards its solution by some of the competitors than might have been expected. Much, however, yet remains to be done to remove the difficulties of application, inconvenience, or even danger attending breakage of parts, first cost, cost of renewals, inconvenience caused by the necessity for frequent renewal of small component parts, and the absorption of power.

The Gordon-Bennett Race.

A Frenchman again, a new type of French car, phenomenal speeds, Imperial German approval of motor racing openly displayed (of the Imperial disappointment I need say nothing), and *qui bono?* Such are the phrases that occur most rapidly to the mind of the British automobilist in reviewing the famous Gordon-Bennett race. Here let me pause to record the result:—

1. Théry, Richard-Brazier (France).
2. Jenatzy, Mercédès (Germany).
3. De Caters, Mercédès (Germany).
4. Rougier, Turcat-Mèry (France).
5. Braun, Mrecédès (Austria).
6. Sallaron, Mors (France).
7. Lancia, Fiat (Italy).
8. Girling, Wolseley (England).
9. Werner, Mercédès (Austria).

The race was happily free from serious accident, and unquestionably proved an exciting and stimulating spectacle, but it is gratifying to find that manufacturers are at last waking up to the fact that these speed tests are not remunerative, and must sooner or later give place to reliability tests.

The 1904 Motor-Bicycle.

Dr. J. Barcroft Anderson, of East London, South Africa, writes: On page 367 of your number for April last you quote Mr. B. H. Davies on motor-cycles. He speaks of the detachability of the engine as being the chief desideratum, but a practical impossibility. Perhaps you will allow me to suggest a solution of this practical impossibility as follows: Place the engine on the left side of the back wheel behind the back forks, have its crank shaft carrying a small number of cogs gearing into a larger cog wheel on the left side of the rear hub. An accumulator or oil tank or both to be carried on the right side of the hind wheel to counterbalance. With this position the whole motor part could be so constructed as to be removed from the cycle like a luggage carrier; or the engine could be disconnected by a lever on the handle-bars, by means of a modification of the Sturmey and Archer three-speed change gear; or it could be disconnected by sliding the cog wheel on the crank shaft to disconnect with that on the hub. A bicycle such as described could be built without the use of parts other than such as are already on the market. It might look a little clumsy at first, but not more so than a bicycle with a hind luggage carrier well loaded. All the inter-frame space would be available for extra carrying capacity.

OPENINGS FOR TRADE ABROAD.

France—Indo-China.

Tenders are invited for the construction of a hauling ship at the port of Haiphong. The adjudication will take place at Haiphong, two days after the arrival of the Messageries Maritimes mail-boat, which is due to leave Marseilles on August 7th, 1904. A deposit of about £400 is required to qualify any tender.

Spain.

H.M. Consul-General at Bilbao writes: There are visible signs of a decided increase and greater energy in agricultural pursuits and labour in the whole of Spain, and it would not be surprising to see a general and rapid adoption of agricultural machinery taking place.

Bulgaria.

A Bill has been passed by the Bulgarian National Assembly authorising the Government to inquire into the best means of constructing a railway across the Balkans, and to effect a loan in order to carry out this work.

The suggested line, starting from Tirnovo, will pass through the rich coal beds of Trewna, and effect a junction with the two existing railways which run parallel with the Balkan range, either at Stara Zagora or, according to a more recent scheme, at Nova Zagora.

Argentina.

The new harbour works at Rosario are to be constructed at a cost of £2,320,000. The work will include all up-to-date accessories, including dredgers, repairing plant, construction of sheds (goods deposits), railway plant, weighing bridges, embankments, levelling, paving, lighting and dredging of channel in the port.

The contract will last for forty years, at the end of which period the entire works and all accessories are to be handed over to the Government in good condition.

The whole works are to be completed within seven years from the time of signing the contract.

The total frontage of the works is fixed at 2½ miles, of which 1½ miles must be of stone and 1 mile of wood. The channel in front of the wharves is to be dredged so as to give a breadth of half a mile, with a depth of 23 ft. at low water. Reclaimed land is to be filled in and levelled. The sand banks now obstructing part of the port are to be removed by dredging.

Russia.

It is proposed to equip the St. Petersburg street railways with electric power, thus doing away with the horse cars. For this purpose, the City Council has appointed a commission to ascertain and report if the River Wuoska is capable of furnishing enough motive power.

South Africa.

There is an increasing demand for traction engines and motor wagons in South Africa, especially in connection with the mining industry. Although steam motors will always be in great demand, the advantages possessed by gas and oil motors are generally recognised, and there are places where their employment is indispensable. In many districts the only available water rapidly incrustates, rendering the use of steam boilers undesirable. In these places, therefore, gas or oil motors will have to be resorted to. The former are likely to be used in towns, as in the country their advantages would be neutralised by the difficulty of obtaining gas.

Transvaal.

The Johannesburg Municipal Council is prepared to receive tenders for insulated cables and bare overhead conductors and certain accessories in connection with the Municipal Tramways and electricity supply for Johannesburg. General conditions, specification and forms of tender are obtainable at the offices of the Council's Consulting Engineers, Messrs. Mordey and Dawbarn, 82, Victoria Street, London, S.W.

Tenders are to be sent in by Monday, July 4th, 1904.

Natal.

During the ensuing session Bills will be introduced into the Natal Parliament to empower the Governor of the Colony to make, maintain, and equip the following lines of railway, viz.:—

1. From the main line to the village of Weenen.
2. From Howick Station to the village of Howick.
3. From the Umlaas Road Station to Mid-Illovo.
4. From Ginginhlovu Station to Eshowe.
5. From Donnybrook to Underberg, Ipolela.
6. From Esperanza Station to Stuartstown, and thence to the Natal-Cape Line.

Greece.

The mineral resources of Greece are undergoing further exploitation, and a demand will probably arise for mining plant; this would necessitate the construction of light railways for the conveyance of the mining plant from the coast and of the minerals from the mines.

Mexico.

The Mexican Government has granted a concession to the Campanía Carbonífera de Monterrey, for the construction and working for a term of 99 years of two lines of railway (standard gauge) in the State of Coahuila, one connecting the Menor coal mines with a point on the international Mexican Railway, and the other connecting these mines with the town of Muzkuiz.

Servia.

The Servian Government has decided on the construction of two narrow-gauge railway lines, each about 112 miles long, from Belgrade to Valjevo, and from Paratchin to Taëtchar respectively.

AMERICAN RÉSUMÉ.

By Our New York Correspondent.

NEW YORK, June 19th, 1904.

Sidelights on the American Shipping Question.

The question of what can be done to revive American shipping has produced a wide divergence of opinion, and incidentally the efficiency of the British mechanic has been thrown into relief.

C. B. Orcutt, President of the Newport News Shipbuilding Company, created surprise by saying that ships can be built in England for 75 per cent. less than they can be built here. "You surely cannot mean," said Representative McDermott, "that a ship costing $400,000 here can be built in England for $100,000?" "I think my figures are right," was the reply. Later his estimate was from 75 per cent. to 40 or 50 per cent.

Lewis Nixon said Americans had been building too good ships for their use. The English tramp is built in a yard which builds nothing else. "We cannot build the British tramps," he said, "because there is no demand for them here. With the demand for such ships, I believe we will rise to the occasion and produce them." Mr. Nixon said he favoured differential duties, which would make a demand for American ships, because through differentials even foreigners would be induced to ship goods in American bottoms. He opposed subsidies out of fear that they would violate democratic doctrine in granting favoured privileges.

Rear-Admiral Bowles said the only advantage Americans have over English and Scotch builders is in wood, of which little is used in cargo carriers. Steel plates here are 50 per cent. higher. The wages here exceed those in English yards by from 30 to 60 per cent. He added: On July 1st of last year I made a list of the battleships and armoured cruisers building in this country and England. To my surprise, I found that the cost was the same here as in England. Why? If the American builder bid in a business way this would have been impossible. But there has been cut-throat competition to get the contracts for battleships. There is not a battleship building at a price which the builder can afford. In the English yards the ships are built at the same price as in the navy yards.

Electrical Progress.

In the report of the Committee on Progress at the Twenty-seventh Convention of the National Electric Light Association, the figures and growth of the industry were shown, and the power plants of the lighting and railway systems of the country were contrasted. In 1902 the dynamo capacity of the street railways was 1,204,238 h.p., and that of the lighting plants was 1,615,480 h.p. German and English plants average larger than ours. In 1903, 5 watts of new apparatus was installed per head of population in Spain; in Germany 7·5 watts in 1902; 12 watts per head in England in 1902–3; and 16 watts in the United States of America in 1902. Madrid has 66 watts installed per inhabitant, as compared with 48 watts in Berlin. The profits of the Spanish stations run high, reaching frequently 30 to 35 per cent. Details were also given as to London and Paris, the price per arc in the latter city reaching $240.

The Convention was attended by central station men from some 200 towns and cities. The total attendance reached 1,150.

Opportunities in the Electrical Business.

One of the most interesting papers read before the Western Society of Engineers in recent years was that contributed by Mr. George A. Damon, M.W.S.E., on the above subject. In order to clear up certain points as to the method of training, and the most successful plan for an embryo electrical engineer to pursue, the author sent a letter of inquiry to one hundred of the leading men in Chicago engaged in the various branches of the electrical industry. An opportunity was given at the same time for the expression of opinion on various questions pertinent to the general subject. The response to the circular letter was hearty and spontaneous.

Ages and Salaries.

Young men control the business. The inquiry was, therefore, confined to men between the ages of 27 and 45, upon the theory that the older men are the product of a set of conditions which have passed away, while the youngest men are, as a rule, still engaged in a period of preparation. The average age is $33\frac{1}{2}$ years. The hundred men were divided into groups as follows:—

	No. of Men.	Average Age.	Average Income.
Salesmen	7	33	$2,400
Sales Managers ..	11	36	3,400
Business Men	10	36	4,800
Sales Engineers ..	8	35	2,350
Electrical Engineers ..	16	33	2,800
Constructing Engineers	6	33	2,850
Electrical Experts ..	8	33	3,200
Operating Engineers ..	3	32	2,250
Operating Managers and Superintendents ..	10	34	3,550
Professors and Editors	8	34	2,500
Patent Attorneys ..	4	32	4,000
Consulting Engineers..	9	40	6,400

Total number of men, 100. General Averages: age, $33\frac{1}{2}$ years; Income, $3,440.

Classified in reference to incomes, the record is as follows:—

	Men
Income over $10,000 per year	5
Income between $5,000 and $10,000 ..	9
Income between $2,400 and $5,000 ..	66
Income below $2,400	20
Total	100

Points that Pay.

An effort was made to make the list representative, and the men were selected on account of their positions without reference to their incomes. It was shown that salesmen who have technical ability or possess engineering information, as a rule, get better salaries than those who do not. Add initiative and executive ability to the salesman's ability, and he becomes a sales manager with a still greater reward. Enterprise and energy put the man in possession of his own business, or often result in a partnership arrangement. A technical man without the commercial instinct is only fairly well paid. Ability to develop new methods or apparatus puts him in the expert class where the rewards are greater and in proportion to his ability. Routine work, such as operating, is the least remunerative work of all. Operating managers and superintendents, however, are very well paid.

The phenomenal development along all electrical lines, and particularly in the telephone business, makes the profession of patent attorney a paying one for those who are qualified for that kind of work. The field of consulting electrical engineering looks attractive, but it will be noted that the average age is greater in this branch than in the others, which means that the successful consulting engineer brings to his work years of experience, and that it is therefore not a branch to be adopted at once by the young man.

Forty per cent. of the men in the list are employed by what might be termed the "large" companies, such as the Western Electric, Chicago Edison, Chicago Telephone Company, etc. Thirty-five per cent. of the men either control the business in which they are engaged or own a partnership interest. Twenty-five per cent. of the men are not college graduates. Twenty per cent. of this hundred successful men never had any college education whatever. The average age of the twenty men who are succeeding without a college education is 36 years, and their success measured by a monetary standard shows an income of $3,670 per year.

Training.

The answers to the questions upon which an expression of opinion was asked resulted as follows :—

Eighty per cent. are inclined to think that a college education is essential to the highest success. Seventy per cent. are in favour of the technical graduate taking a shop course in a large manufacturing company, but many wished to limit this course to one year. Fifty-five per cent. are of the opinion that in choosing a life work better chances for advancement will be found with the smaller companies. Seventy per cent. are in favour of requiring a year's practical work of the student before graduation. Fifty-five per cent. agree that the larger companies would be consulting the interest of the art at large by offering an apprentice course open to students during an intermission of one or two years before completing the senior year.

Opportunities.

Each of the hundred men included in the inquiry were asked to name the three fields which he considered most promising within the immediate future, and the votes received are as follows :—

Electric Railway Work	63
Telephony	36
Transmission	30
Electro-Chemistry	29
Power Applications	21
Lighting Developments	12
Manufacturing	11
Central Station Work	9
Patent Law	6
Consulting Engineering	6
Contracting	5
Management of Properties	5
Storage Batteries	4
Reconstruction of Plants	3
Mining	3
Metallurgy	3
Turbines	2
Wireless Telegraphy, Designing, High Speed Telegraphy, Underground Conduit Construction, Isolated Plants, Train Lighting and Municipal Lighting .. .. each	1

As a result of personal observation, tempered somewhat by the opinions of the electrical men, with whom the questions have been discussed, the author presents the following conclusions :—

Value of a College Education.

A young man wishing to succeed in any branch of electrical industries makes a serious mistake if he fails to use every effort to obtain a technical education. A college course is becoming easier to obtain, and it is already recognised as a general requirement for advancement. A young man of high aspirations, who is so situated that he cannot secure a university course, might better, nine times out of ten, take up some other branch of work which is less intricate than the electrical art. Thomas Edison, the Dean of the profession, is not a college man, but a gold medal bearing his name is to be given hereafter each year to the college graduate presenting the best thesis, and this incident is the best evidence of the present tendency toward technical education. Nearly every man who is now making his way in the electrical business without a college training, if asked what he would do if he had his life to live over will say : "I would secure a technical course in the best college I could find."

Considerable attention is being given to develop the best technical course, but a college training is less than half of an education. What constitutes the other half is a big problem waiting for a comprehensive answer.

At the same time, the author emphasises the necessity of practical experience. Considerable attention, he says, is being given to develop the best technical course, but a college training is less than half of an education. What constitutes the other half is a big problem waiting for a comprehensive answer. The trouble with a great many young men is that they don't "find" themselves early enough in life. They fail to realise the possibilities and are not prepared to grasp their opportunities. Ambition, aptitude, preparation and hard work are the stepping-stones to successful attainment.

SOUTH AFRICAN RÉSUMÉ.

BY OUR JOHANNESBURG CORRESPONDENT.

Railway Problems in South Africa.

The report of the working and maintenance of the Cape Government Railways for the year 1903 is an interesting document of 160 pages, giving an instructive insight into the exceptional difficulties encountered, and *inter alia* showing the far-reaching effect of the prolonged drought, and is accompanied by a number of diagrams, and a railway map with the routes printed in colours, a reproduction of which will be found on the opposite page.

Accounts.

The capital entitled to a full year's interest for 1903 amounted to £24,945,974, as against £23,154,083 in 1902.

FINANCIAL RESULTS.

Total Earnings.	1903.	1902.
Passengers and Parcels ..	£1,631,001	£1,375,291
Goods and Minerals	3,299,738	3,525,543
Vehicles, horses and dogs ...	68,613	93,754
Livestock	127,069	99,136
Mails	30,724	34,557
Telegraphs, rents and miscellaneous	61,213	49,585
Cartage	105,083	86,155
Hire of Rolling Stock by Foreign Lines..	6,427	27,606
	£5,329,868	£5,291,627
Total Expenditure	£4,522,590	£3,779,256
Credit balance after paying working expenses	£807,278	£1,512,371
(Decrease, £705,091)		
Deduct Treasury interest charged on Capital Expenditure at £3 16s. per cent. for 1903, on £24,945,974, and for 1902 on £23,154,083	947,947	879,855
Balance + or — after payment of working expenses and interest on Capital	—£140,669	+ £632,516

The net Earnings per cent. on Capital entitled to a full year's interest for 1903 amount to	£3 4 9
and for 1902 to	6 10 8
or a decreased percentage as compared with 1902, of	£3 5 11

The expansion of trade generally within the Colony is the most satisfactory feature in the Revenue Statement, and although the earnings may not give such a good result when reduced to net profit, it shows clearly that the railways are fulfilling the purposes for which they were projected, viz., developing the resources of the country and minimising the losses which are ncurred by constantly recurring droughts.

Once the additional labour supply in the Transvaal is provided for, the general manager anticipates that within a limited period trade will increase rapidly, so that it is advisable to continue the policy at present obtaining of placing the rolling stock in thorough repair, and of improving the main lines by regrading and relaying with the heavy type of permanent way.

Prospective Economies.

With a falling revenue and a further increase of capital on account of new lines now under construction, which are not at first expected to pay working expenses, the strictest economy will be required to make both ends meet, and steps have already been taken to a certain extent to reduce expenditure; but, much as it is to be regretted, I fear measures will have to be adopted to ensure this by curtailing the passenger train service where it has been increased beyond what is now warranted, and, following the course adopted elsewhere under similar circumstances, by limiting the time to be worked by a considerable portion of the staff, and not replacing men who fall out in the ordinary course, when this can be done without impairing the efficiency of the service.

Alternatives are (1) withdrawal of the 8½ per cent. temporary increase granted to daily paid employees; (2) shortening hands. If the railway receipts do not improve it may become necessary to adopt both alternatives, viz., the shortening of hands and withdrawal of the 8½ per cent., otherwise rates must be raised so that the revenue be increased, and in this connection a beginning should be made on the fares on all the suburban lines.

Rolling Stock.

As anticipated in the last annual report, the department is now capable of meeting all traffic demands without further additions to the stock of either engines or trucks, but in view of the opening up of the new lines and the anticipated revival of trade, further orders will have to be placed when the circumstances warrant it. Composite saloons and native coaches are at present most required.

Fifty-five saloons and carriages were erected and put into traffic during 1903, and there are still 74 under erection and on order.

The following table shows the number and aggregate haulage capacity of engines, and the number and aggregate carrying capacity of trucks in traffic on March 1st, 1904, compared with March 1st, 1903, excluding engines of a lower capacity than sixth class :—

ENGINES—6TH, 7TH, AND 8TH CLASSES.

	Number.	Capable of hauling on a 1 in 40 gradient. Tons.	Haulage per cent. increase over. 1903.
1st March, 1903 ..	369	73,229	——
1st March, 1904 ..	420	86,410	18·00
On completion of orders ..	443	91,926	25·53

MAP OF THE CAPE GOVERNMENT RAILWAYS.

	Trucks. Number.	Carrying capacity. Tons.	Capacity per cent. increase over 1903.
1st March, 1903 ..	10,492	106,821	——
1st March, 1904 ..	11,936	129,919	21·62
On completion of orders	12,216	133,819	25·27

Water Supply.

Owing to the deplorable drought which prevailed through the greater part of the Colony throughout the year, and the consequent unsatisfactory water supply, both as regards quantity and quality, over £100,000 was expended in connection with the running of water trains, and the expenditure was increased by an unknown sum incurred on account of delays through the breaking down of the engines, caused by the action on the boiler tubes by the use of unsuitable water, and it is a cause of great regret that this large sum should have been practically wasted on work giving no permanent reproductive result. As opportunities have presented themselves advantage has been taken of purchasing water rights, and although in some cases at an apparently high figure, the drought through which we have just passed justified the expenditure.

A fair amount of success has attended the efforts of the department to secure an adequate supply of good water by boring, but large sums of money will still have to be continued to be spent on the improvement of the supply, both by acquisition of rights and by boring, before the position can be considered reasonably safe.

Signalling.

Tyer's Tablet Instruments are now in working on thirty-three sections of the line, and others are now being installed. The working of these instruments is most satisfactory, and as the time taken in arranging crossings by telegram is very considerable, I propose, on account of both safety and economy of time, to push forward with the fixing up of these instruments on stations on the main line where the traffic is of such a volume as to warrant it.

New Lines.

The following summary is given of the new railways opened for public traffic :—

	Miles.	Chns.
Kalabas Kraal—Hopefield (2 ft. gauge).. Opened for public traffic on February 28th, 1903.	46	79
Cookhouse—Bedford (3 ft. 6 in. gauge).. Opened March 2nd, 1903.	24	77
Willowmore—Uniondale Road (3 ft. 6 in. gauge) .. .. Opened April 15th, 1903.	36	73
Uniondale Road—Vlaakteplaats (3 ft. 6 in. gauge) .. .. Opened August 1st, 1903.	23	18
Vlaakteplaats—Le Roux (3 ft. 6in. gauge) Opened December 14th, 1903.	15	38
Bedford to Adelaide (3 ft. 6 in. gauge) .. Opened December 14th, 1903.	17	55
King William's Town to Middle Drift (3 ft. 6 in. gauge) .. .. .. Opened December 14th, 1903	33	0
Total	198	20

Lines under Construction.

The following statement shows the lines of railway under construction, their length, and the distances over which rails have been laid, up to December 31st, 1903 :—

	Gauge. Ft.	In.	Length of line. Miles.	Chns	Distance over which rails have been laid. Miles.	Chns
Paarl—French Hoek	3	6	17	00	17	00
Victoria West Road —Carnarvon ..	3	6	86	40	20	40
De Aar—Prieska ..	3	6	111	00	35	38
Somerset East—King William's Town ..	3	6	151	51	142	9
Klipplaat — Oudtshoorn	3	6	156	00	154	10
Port Elizabeth—Avontuur ..	2	0	178	00	38	24
Amabele — Butterworth	3	6	78	00	22	30
Indwe — Maclear ..	3	6	107	00	19	75
Aliwal North — Gairtney ..	2 or 2	6 or 0	47	00	Nil.	
Mossel Bay—Oudtshoorn	3	6	71	40	15	26
Total ..			1,003	51	465	12

Ceres Road—Ceres. 10 m. 20 c. Construction not yet commenced.

This, says the General Manager, in itself is a sufficiently large railway programme to give employment to the Construction Department for a couple of years, say at a rate of completion of one mile per day, and in my opinion it is advisable that the question of railway extension should be carefully considered.

Natal Government Railways.

The report of the General Manager of Railways in Natal shows that the total revenue for the year amounted to £2,561,551 10s. 5d., as against £2,046,116 6s. 6d. for the year 1902—an increase of 25·19 per cent. in comparison with the previous year, although on the 1st July, 1903, a reduction took place in the goods rates and passenger fares amounting to the sum of £100,000 per annum, calculated upon the tonnage then offering. At the end of the year there were open for traffic 762 miles, new lines to the extent of 105 miles having been opened during the year, represented by the following extensions of the branch lines: Zululand Railway, Umhlatuzi to Somkele, 53¼ miles; Buffalo-Vryheid Railway, Talana to Vryheid, 51¾ miles. The only extension now under way is that of the Natal-Cape line, 95 miles of which have been placed in the hands of contractors. The past winter season has accentuated water difficulties to an unparalleled degree, and it was necessary to resort to the running of water between stations to a greater extent than at any past period of the department's history.

GERMAN RÉSUMÉ.

BERLIN, June 21st, 1904.

Germany as a Market for Novelties.

According to a recent Consular report there is, in Germany, a quick, eager market for novelties, for practically every new thing, be it a machine, a new lamp, or motor, or fixture of any kind that is inherently original and superior and will do its work cheaper or better than anything of the same kind now in use. As examples of the kinds of machine tools that are wanted, may be cited the following that have been recently inquired for: a full equipment for making small tubs for butter, lard, and other oleaginous products; a machine for cutting a spiral peel or veneer from round logs, which is used for making small boxes and baskets; and bending machines for shafts, fellies, and other parts of vehicles. With the exception of certain special manufactures—typewriters, sewing machines, graphophones, phonographs, cash registers, mechanical musical instruments, dental supplies, office furniture, etc. The German market is narrowing and growing more difficult year by year.

German and English Gothenburg University.

The Board of Directors of the Gothenburg University has received the information that Mr. Andrew Carnegie has made a donation of £10,000 to the University.

The donation, says "Affärsvärlden," is intended for a professorship in the English language. There was formerly one professor of English and German, but, the Riksdag having decided that the teaching of these two subjects is henceforth to be separated, there is now only a professor of German at the Gothenburg University.

Nothing has been published as to the reason which prompted Mr. Carnegie to this act of generosity. It may be, that he feels a special interest for Gothenburg, where members of his family—though distant relations, yet bearing his name—have been active, developed a lively industry and acquired a fortune. Those relations are Mr. George Carnegie, founder of the well-known firm D. Carnegie and Co., in Gothenburg, and Mr. David Carnegie, later on head of the firm in question.

It may be of some interest to recall some dates about those two Carnegies, who occupy a prominent part in the Swedish commercial and industrial world. George Carnegie was born in Scotland and came to Gothenburg in 1746. Here he started business and acquired, through twenty years of commercial activity, a certain fortune, with which he went back to Scotland, leaving his business in Gothenburg to a young Scot, Mr. Thomas Erskine. The latter, however, soon left Gothenburg, and his business was taken over by a young relation of Mr. George Carnegie's, called David. Under the name of D. Carnegie and Co. the firm grew quickly and attained a considerable importance, while it steadily increased the fortune of the Carnegie family. The concern includes porter brewery and sugar works.

Mr. David Carnegie lived in Gothenburg until 1841, when he settled in Scotland.

Tests on a 4,000 h.p. Steam Turbine.

In connection with the Dresden Exhibition of German Civic Life, the municipal electricity works of Frankfurt-on-Maine published some tests made on a 4,000 h.p. steam turbine (system Brown-Boveri-Parsons), which had been installed in one of their central stations. The turbo-dynamo is designed for an entering pressure of 13 atmospheres for superheated steam at 300° C., giving outputs as high as 2,600 kilowatts at a pressure of 3,000 volts, 1,360 revolutions per minute, and an efficiency of 0·8; it is 16·5 metres in length, 2·5 metre in breadth, and 2·5 metres in height. All the parts of the steam turbine are easily accessible, the whole of the interior becoming visible through unscrewing the upper cylinder cover. The engine is of very easy and simple operation and superintendence, only fifteen minutes being necessary to preheat the turbine cylinder from the cold state. The regulation of the turbine is extremely accurate, the steam requiring to traverse the turbine only a fraction of a second so as to make the effect of controlling on the only inlet valve felt instantaneously. Though the steam enters by jerks, the uniformity in the working of the engine is most remarkable. The turbo-alternator works readily in parallel with other alternators operated by reciprocating engines, the more so as the rotating magnet field is analogous to the rotors of asychronous motors.

The following table records some experiments made in the course of normal operation, the figures stated being average values:—

Steam pressure before inlet valve. At.	Temperature of superheated steam °C.	Load in Kilowatts.	Vacuum per cent. of barometer reading.	Steam consumption kg./KW.-hour.
12·63	298	1,945	93·2	7·20
12·8	295	2,518	91·8	7·09
10·6	312	2,995	90·0	6·70

According to the contract the steam consumption was to be not higher than 7·2 kilogrammes for a superpressure as high as 12·8 atmospheres, a superheat of 300° C., and a load of 2,600 kilowatts. From the above table it is inferred that the actual steam consumption is much below these figures, showing the steam turbine to work at least as economically as the most perfect reciprocating engines of the same size.

Iron and Steel Syndicate.

The recent formation of the German Steel Makers' Association is an event so important and momentous in its consequences as to require more than a passing notice. For a number of years past the German iron and steel industry has been organised under six special groups, viz., the pig-iron, the ingot and steel-billet, the drawn-wire, the girder, the plate, and wire-rod syndicates, but no effort had hitherto succeeded in uniting them all into one comprehensive and all-powerful trust under a single central management. Each of these syndicates, and even some individual ironmasters, operated independently, with the result that during the dull and depressed period since 1900 vast quantities of German iron and steel have been dumped into foreign markets—particularly Great Britain—at prices which were often below the net cost of production. This competition between German makers underbidding each other in their foreign trade has been of great advantage to many consumers of steel and iron in England, France, Belgium, and even the United States, which latter country has taken shipments of special qualities adapted to the manufacture of electrical machinery. Whole cargoes of rails and other railway material have been bought in Westphalia, sent as ballast in grain ships round Cape Horn, and used by the railways that terminate on the north-western Pacific coast. For obvious reasons this dumping policy has worked unfavourably for Germany, since foreign consumers of cheap half-finished materials could undersell with their finished goods the German manufacturers who had to pay syndicate prices for their supplies. All this, says the American Chamber of Commerce Bulletin, is now to be changed.

MINING NOTES.

By A. L.

Miners' Scourges.

The Special Inquiry directed by the Home Secretary into the question of miners' lung disease in Cornwall has shown that the constant inhalation of dust is responsible for the enormous increase in the death-rate among Cornish miners. It is also quite clearly brought out that the high death-rate has been among the men who have worked rock-drills, the predisposing cause being manifestly the inhalation of stone dust. Various methods of preventing the dust from reaching the lungs are discussed, and it is shown that none of the various inhalers hitherto introduced can be relied upon for the purpose. It is recommended that the use of rock-drills, without satisfactory precautions to prevent the men from inhaling the dust produced, should be prohibited in all mines, and that special rules should be established under the Metalliferous Mines Act, by the managers of every metalliferous mine, subject to the approval of the Secretary of State, for carrying on the work in such a manner as to reduce to a *minimum* the inhalation of dust by the various classes of men employed.

It is stated that the dust produced by rock-drills can easily be prevented by even a very small water jet, while the dust from blasting can at once be laid by a powerful jet of water and air, and can in any case be avoided. The inhalation of dust produced by blasting on the stopes can also be avoided, and the dust incidental to handling the ore can mostly be prevented by keeping the workings damp.

Ankylostomiasis.

Here one recalls with interest the discussion on the dreaded miners' worm disease at the recent meeting of the Institution of Mining Engineers.

It was strongly impressed upon the members that a warm damp atmosphere is most favourable to a spread of the disease. More than one member seemed in doubt as to the value of stringent sanitary precautions in mines. If, in order to avoid miners' phthisis the workings of a mine must be kept damp, it becomes more than ever obvious that the dangers of ankylostomiasis will compel the adoption of improved sanitation.

Miners' Phthisis Competition Commission.

In South Africa the Chamber of Mines Miners' Phthisis Competition Commission has issued its official report. There were in all 229 competitors, but many of the suggestions were condemned as quite impracticable.

Of the various atomisers submitted, Mr. Thomas J. Britten's is considered the most perfect mechanically, and therefore the most useful machine. It was found to lay 75 per cent. of the dust in the drive where it was tested (*vide* Dr. Pakes' report of April 23rd, 1903), and would, therefore, probably lay a like percentage during blasting and shovelling. It can be used during drilling and blasting, and also whilst shovelling is being done in drives and stopes. It further possesses the distinct advantage of laying the nitrous fumes contained in the gases after blasting.

If a little lime be mixed with the water used, a portion of the carbonic acid resulting from blasting would also be absorbed. It assists local ventilation and is simple and cheap in construction. On the other hand, it involves a separate mechanism, requiring extra attention which causes a disinclination on the part of the miners to use it. It is not necessary to the successful running of the drill, and its use, therefore, depends on the goodwill of the miners. The latter might prefer to discard it rather than bother with it. It involves the necessity of working in a supersaturated atmosphere, which disadvantage, however, is a negligible quantity if change houses are used by the men. It necessitates absolutely a supply of pure water underground for use with the atomiser, and therefore some system of water supply in the mine which would be more or less costly. The judges are of opinion that Mr. Britten's atomiser is the best practical device that has been suggested, and therefore award it the first prize of £500 and the gold medal.

In the opinion of the judges, the best means of combating the disease would be the use in drilling of a perfect water drill, together with the use of an atomiser for allaying the dust and gases during blasting and shovelling.

They award the full amount of the second prize, £250, to the Leyner Drill as being the best device submitted which embodies what the Committee considers to be the ideal principle in actual drilling, although the drill in its present state is not considered sufficiently perfected to enable the judges to recommend it for general use.

Origin of the Commission.

The circumstances which led to the appointment of the Commission were explained by Mr. A. R. Goldring (London Secretary of the Transvaal Chamber of Mines) in the course of a discussion by members of the Institution of Mining and Metallurgy, following a paper on Miners' Phthisis by Dr. Haldane and Mr. R. H. Thomas. Mr. Goldring remarked that it was through the Transvaal that the question of miners' phthisis had come into prominence. Out there, so far as he was aware, they had no knowledge of the disease until the period of the war. Then paragraphs appeared in the English papers, which were received out there, showing that men who had worked in their mines

had come back home, and a certain number of them had died in Cornwall from a disease which it was said was contracted in the Transvaal mines.

The matter naturally caused the very gravest concern. The men out there who were responsible for the working of the mines could not but regard the matter as one of the highest importance, and measures were immediately taken to endeavour in some degree to cope with the danger. Water jets and sprays were both tried; various kinds of respirators were sent to the Chamber by persons desirous of introducing them; they were sent into the mines and tried, but, as Dr. Haldane had remarked, it was very difficult, owing to the discomfort caused by the respirators, to get the men to use them; and as a matter of fact they did not come into use. Having tried various experiments, the Chamber, which was the representative body of mine-owners, desired to get the best information that it was possible to obtain for dealing with the disease, and in October, 1902, they proceeded to offer prizes, and to advertise their proposals for suggestions in the press of England, Australia, the United States of America, and the Continent, in order to draw suggestions from all parts of the world.

A committee of judges was formed, and on that committee there were two members of the medical profession, two members of the Mines Managers' Association, three consulting engineers, two mechanical engineers, and two practical rock drill miners—Dr. Pakes, the Government bacteriologist, being subsequently added.

In course of time, within the prescribed time limit, about 230 suggestions were sent in, some of them accompanied by models of apparatus. The Chamber placed at the disposal of the Committee whatever means they might require to test the apparatus so as to get at the best means for allaying the dust, it having been assumed very early that dust was the determining cause of miners' phthisis. The various mining companies gladly afforded the necessary facilities for making the tests. Further, in connection with deaths on the mines from lung complaints, the Chamber made a grant of £1,000 towards the cost of a thorough investigation into the causes of pneumonia. Subsequently a Government Commission was appointed.

The high mortality among rock-drill miners who had worked in the Transvaal mines had caused very great concern. What could be done to grapple with the danger had been done, and any means which human knowledge or human ingenuity could suggest would be applied by the men who were responsible for the working of the mines of the Transvaal, and responsible in the first and highest degree for the safety of the men, both whites and natives, in their employ.

Cinnabar-Bearing Rocks of British Columbia.

Points on the quicksilver-bearing zone of British Columbia, included in a paper by Mr. G. F. Monckton at the recent meeting of the Institution of Mining Engineers, served to illustrate the many difficulties encountered in this form of mining.

The whole country bears out the comprehensive description of the puzzled miner who said that it was "hove, busted and swung around, and then hoisted and broke and shook." Mr. Monckton has had the advantage of studying this district intimately after some £15,000 had been spent on underground work, and a considerable sum expended on cutting trails round the steep sides of the hills, which exposed many rocks hitherto invisible.

It is pointed out that the cinnabar always occurs in the dolomite near porphyry; thus on the Briar mine (Rosebush of Dr. Dawson) the porphyry is from 10 ft. to 50 ft. away; on a chain south of Kamloops Lake it is on the contact; on the Toonkwa about 30 ft. distant; on Sabiston Creek it occurs in a seam of dolomite separated from the main bed by porphyry. At one point on Criss Creek it is only 5 ft. from porphyry; at another on the contact; and in a third case is in a narrow seam of dolomite, between porphyry and conglomerate. This would tend to show that the deposition of the cinnabar was due to the heat generated by volcanic action, at a period subsequent to the deposition of the dolomite. In many cases, notably at Hardie Mountain, the fissures of old hot-springs may be seen. One may, therefore, gather that the formation of these deposits took place over a long period of cooling, subsequent to the era of volcanic action which resulted in the accumulation of 5,000 ft. of strata in the Tertiary period.

More work has been done on the property owned by the British Columbia cinnabar mines at the mouth of Copper Creek than on any other. About £10,000 in all has been expended on this mine. The first week resulted in the extraction of about 150 tons, from which 114 flasks, worth about £900, were obtained. The management then decided to mine low-grade ore and to treat it on a large scale, and for this purpose a 25 tons Grauza coarse ore furnace was built. Several hundred tons were treated in this, but the results not being satisfactory the works were closed down in 1897.

Cinnabar has been found in many places in the district, some of which are a little outside the main quicksilver-bearing zone, but they are at present of no importance, although its occurrence in a bed of dolomite north of Cherry Creek, 10 miles east of Copper Creek, may be said to offer possibilities of other large deposits, as this dolomite extends many miles south of Kamloops Lake. The fact that the higher part of the mountains is much covered with lava-flows and deep surface soil is a stumbling-block to the prospector. The liberal conditions of British Columbian mining laws have also militated against the development of this form of mining, as they have enabled parties to hold large areas without working them in hopes of selling for high prices. This hope, however, has been falsified and the only holders now are miners who are slowly developing their properties. There is plenty of room in the district for prospectors, both to work abandoned claims and to search for new croppings of ore. It may be said that the area of the dolomites alone which are exposed is not less than 10 square miles, hardly any of which has been tested. The great need of the district at present is a furnace to give working tests. The only alternative is to ship ore to Great Britain, which is only practicable with very high grade ores.

OUR TECHNICAL COLLEGES.

By A TECHNICAL STUDENT.

MORE STUDENTS WANTED AT CARDIFF.

THE Cardiff Technical Instruction Committee recently met to discuss the best means of increasing the number of students at the classes. Finally, it was decided to let a deputation wait upon certain local employers. It will be interesting, in view of the alleged apathy of the British employer in matters connected with technical education, to see how far this experiment is attended with success.

THE ENGINEERING FACULTY OF KING'S COLLEGE, LONDON,

At the forty-fourth annual dinner of King's College, London, Lord Salisbury presided and proposed the principal toast, viz.: "King's College, London." In the course of his reply, Dr. Headlam remarked that last year a great deal was said about the engineering faculty. They had then to report of a new movement to enable students to spend half their year in the college and the other half in works practising their trade. They had now worked out the system, which had begun to act. This spring a considerable number of students who had been at work in the college for six months were passed on for the next six months to practical work in various places. How far the experiment would be successful he could not say; but up to this point the council saw no reason to change the opinion which they then formed, and they believed the experiment would be of the greatest value in engineering education. Not only was the engineering faculty flourishing, but the size of the electrical engineering faculty had been doubled, and an opportunity for studying motor electricity in every form—an important branch which had not been adequately treated in London before—had been introduced. Both in arts and in science there was a larger number than they had had for many years past of matriculated students going through the regular course of the London University.

DURHAM COLLEGE OF SCIENCE EXTENSION.

The extension of Durham College of Science is proceeding apace, and will soon be a reality in stone and red brick. It includes the principal wing and elevation, about 100 yards in length towards the Leazes, and an examination hall and lecture-room, 70 ft. by 50 ft., lighted from the quadrangle. The buildings are to be four stories in height, including a central tower 120 ft. to the parapet, which encloses the main entrance, opening into a spacious hall 23 ft. in width. On the right of the main entrance is the secretary's room, and contiguous thereto are the clerks' office, an electrical engineering laboratory and a mining laboratory. Opposite to the tower entrance is the grand staircase, and beyond it a large examination hall connected with the corridors on three sides. On the first floor is a library, 60 ft. by 45 ft., lighted on two sides, and class-rooms for mathematics, literature, naval architecture, etc., as well as professors' rooms. The floors are of fireproof construction, covered with pitch-pine flooring, and the dadoes are of oak, pitch-pine, and glazed bricks. Mr. W. H. Knowles, of Newcastle, is the architect, the contract amounting to £50,000.

IRISH TECHNICAL SCHOOLS

At the recent Technical Congress held in Dublin, Mr. L. F. O'Carroll, B.A., Director of the City of Dublin Technical School, read a paper on the past and future of technical education in Dublin. He said that Dublin had the honour of being the pioneer of technical instruction in Ireland, and traced the progress of the movement from the Artisans' Exhibition in Dublin in 1885 to 1901, when Mr. Arnold Graves resigned his place on the committee, after fifteen years' earnest work. Two months later the new wing in Kevin Street was opened for classes, and although the scheme for the City of Dublin had not been finally approved of, the actual work of technical education in Dublin had been continuous and vigorous.

One of the speakers at this Congress, Mr. F. C. Forth, Principal of the Belfast Municipal Technical Institute, said his experience was that the pupils coming to the technical schools were most inadequately prepared for technical work. They had not the fundamental knowledge which would enable them to profit by the instruction given. Consequently, a great deal of work attempted to be done was missing its mark, and the funds available were to some extent being wasted. The students were not making the progress they ought to do, and he believed that was fairly general all over Ireland. That explained why their science and art grant was so low. Their students had not risen to the level attained by students more favourably situated, and they could not earn the percentage of the grant which was being earned elsewhere. The sum of £3,000 earned in Ireland was ridiculously small for the number of pupils. If they had an ideal system the young people who left the national schools would pass into a lower grade of the technical school, then, perhaps, to a somewhat higher, and then to work. They could not hope for that yet, because the pupils were sent to work directly they were allowed to do so on leaving the national schools.

What were they to do with these pupils to make sure they got the full benefits of technical education? Several remedies had been suggested. Managers of primary schools could do a great deal, but he believed they would have to look very largely to the employers throughout Ireland to help them. If employers would only make some stipulation with the young people that they should attend an evening technical school or a continuation school, and carry out their education there, it would greatly assist them, and he thought they would be on the right road. Employers could assist them also by paying a portion of the fees of the pupils to the schools. He certainly would not recommend the paying of all the fees. The employers could also assist in the purchasing of books and instruments necessary for the students' work, and they could help by following up the progress of the pupils' work. It was to the material interest of the employers, not to speak of their patriotic feelings, to do this, and he hoped they would make an effort in the direction outlined.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE FUTURE OF THE SUBMARINE.

MR. ALLAN H. BURGOYNE, who recently read a paper on "The Future of the Submarine Boat," before the Royal United Service Institution, is convinced that we are on the eve of a revolution in naval construction, and that in the near future we shall hear of submarines, or, rather, "submersibles," of thousands of tons. He sums up his idea of the submarine of the future, as follows: It will be of large tonnage, the displacement being governed by the extent of the armament and internal fittings; of good speed, at least twenty-five knots on the surface; well armed, by which I imply from four to six torpedo tubes and an equal number of small quick-firers; well protected by an armoured deck, and, lastly, well provided for in the matter of safety appliances, for it would be deplorable if the officers and men who devote their lives to submarine navigation should not be given the same chances in the event of an accident as their fellows of the upper sea; and it is due to the nation that the future policy of our Admiralty in this respect should be made public. In the course of his introductory remarks he observes that all vessels of to-day are but the evolution of time, and the smaller the beginning the greater the finality. Already it is hard to believe that whereas in 1890 the French possessed only the *Gymnôte*, of 30 tons, now, fourteen years later, they have six submersibles of no less than 422 tons on the stocks. We in England were somewhat tardy in our adoption of this novel type of war vessel, and, as a consequence, are not only behind several other Powers in numbers, but also in efficiency. Because the submarine boat does not appeal to the British mind, it is no reason why England should not possess them, given, of course, an efficient type.

THE PERFECT SUBMARINE.

He defines the perfect submarine for naval purposes as follows:—

It would be a vessel of special type, the shape to be determined by experiment, but with no speciality of form essential, capable of navigating not only on the surface, as an ordinary ship, but also beneath the surface of the sea, and continuing its course in a direct line for the object it is desired to reach, whilst retaining stability in every sense, and being under the complete control of its commander; and besides conforming with these conditions it must possess the maximum of speed, safety, offensive power and habitability, a trustworthy means of propulsion, and a complete independence of all exterior help while in action.

With these conditions laid down, the author proceeds to divide up the various problems of submarine navigation into sections.

FORM—THE FINAL PHASE OF THE SYMMETRICAL SUBMARINES.

In the *Gymnôte* we have a form which, whilst possessed of little longitudinal stability, represents the maximum of resistance. There is nothing so capable of withstanding enormous outside pressure as a sphere, and next in strength comes the double-ended cone. For the exploration of great depths, therefore, the form adopted by MM. Gustave Zédé and Goubet presents every advantage, but I fail to see the value of this advantage, if such it be. The *Goubet*, as we know, is capable of withstanding the pressure at a depth of about 5,000 ft., or very nearly a mile beneath the surface; our own *Holland* is capable of navigating safely at 150 ft. The difference is astounding; even if we allow the *Holland* a margin of safety equal to 850 ft. (an altogether disproportionate allowance), the *Goubet* is yet five times as capable of withstanding external pressure as the American boat. The value of this immense strength is, however, not apparent, and there is little doubt but that any advantage it may confer is negatived by the lack of stability attached to this form. The reason of this is easily comprehensible. The vessel is circular in section from stem to stern, and is balanced as a beam by its preponderance of weight in the middle. Now this all-round equality of sections renders a see-saw motion in the longitudinal sense the easiest possible thing, since there is no variation of resistance at any point, and differentiation in the locality and distribution of such resistance is a greater step towards stability than the action of rudders and changeability of water ballast can ever be. Thus, if a member of the crew of a symmetrical vessel walks forward and so causes the bows to dip, the resistance of the water to the lower contour of the forward part of the hull is equal to the resistance of the upper part of the stern section, and the diving angle of the vessel being even over its whole length the deviation is not lightly obviated, and a swing motion is set up which, besides being dangerous

to the vessel should the depth of water in which she is navigating be little, is decidedly unpleasant to the crew, whose pluck, and hence value, would soon disappear under the prolonged tension of essaying to keep their craft on an even keel.

The Turkish sailors absolutely refused to serve on the *Abdul Hamid* and *Abdul Medjid* owing to their switchback-like movements when submerged. Of course this defect in stability is not irremediable, for on the *Goubet* we find the acme of stability, and yet she is of the symmetrical form. This is owing to the height of the centre of buoyancy and the size of diameter as compared to the length. Thus it was only natural that faults which were prominent in the *Gymnôte* should be accentuated in the *Gustave Zédé*, a vessel of far greater length with little additional beam. Therefore, the shorter a symmetrical-shaped vessel is as compared to its diameter, the nearer does it approach a sphere weighted at the bottom, and the greater will the stability be. But in obtaining this necessary stability the fine lines essential to speed disappear, and speed is of almost as much importance as evenness of route when submerged. If a compromise is effected, we obtain a vessel faster than the *Goubet*, but less stable. Such a boat is the *Gymnôte*, and in all probability the *Gymnôte* represents the final phase of the symmetrical submarines.

THE NEAREST APPROACH TO "NATURE'S SUBMARINE."

In the *Holland* we have perhaps the nearest approach to nature's submarine—the fish—that it is possible to obtain. The heavy forward part and the fine diminishing tail are the great features of all the *Holland* craft. This form is so stable that oscillation is entirely absent when submerged especially in the first *Holland* designs, which are short and stumpy. For although the weight is unevenly distributed, the equilibrium is perfect, owing to the fact that in the bows, which support the major portion of the weight, the buoyance is greater, and can thus sustain it, whilst towards the stern the gradually diminishing surface of the hull reduces the buoyant power and thus equalises the pressure evenly over the whole length of the vessel. It will have been noticed that the sharp pointed bow has given way to a blunt nose, and this is due to the same reason that changed the form of the stem of the Whitehead torpedo from a point to a spherical cone. It was found by experiment with models in a tank that the sharp nose, strange as it may seem, offered infinitely greater resistance to the water when in motion than an equal sized model with a rounded, blunt nose. This phenomenon may be roughly explained as being due to the difference of flow of the liquid wave of motion when caused by a sharp point and a blunt nose; thus, if a sharp point pierces the water, the fluid is "forced" on either side and strikes out at an angle away from the hull, whilst with a blunt and smooth stem the water "glides" away from the impact and swirls smoothly "round the lines" of the hull instead of wasting its energy on the ambient water in an ineffectual effort to compress the same. This argument does not apply to surface vessels, owing to the difference between "surface wave resistance" and "submerged wave resistance." As a matter of fact, it is erroneous to say "submerged wave resistance," there being no "wave," but for want of a better term the word "wave" will stand very well for the radiating lines of moving fluid displaced by a submarine boat in motion. On passing the thickest part of the boat, which is about a third of the length from the bows, the flowing water, rushing sternwards to fill the cavity out of which it has been forced, presses tightly on the receding lines of the hull, and the longer the stern "run" (that is, from the greatest section to the propeller) is, the greater is the length of time that this pressure is exerted; the velocity of the backward flowing current is likewise augmented increasingly as it reaches the end, and these two causes (the rapid flow of the displaced water and its pressure on the hull) help the forward motion of the boat and make up almost entirely any power lost through resistance. Of course, it would be foolish to say that the ideal shape had already been discovered, but the *Holland* is very nearly all that can be desired. An ideal submarine vessel would be one in which the frictional resistance was completely made up by the sternward pressure, but this is as likely of attainment as universal peace.

STABILITY.

After discussing various other forms of submarines, the author remarks that :—

The stability of all submarines is governed by their reserve of buoyancy when submerged, for it must be taken as an axiom that every submarine vessel claiming to be successful is stable in its surface condition. The relation of "size" to "reserve of buoyancy" hardly needs discussion, for obviously where a vessel of, say, 500 tons can have a "reserve" of 40 tons, one of 2 tons could scarcely reserve as many pounds. Hence, whilst the movement of a man fore or aft must in a smaller boat completely destroy the equilibrium, in the larger his weight would be so small a part of the "reserve buoyancy" (tending, as such does, in all cases to preserve an even keel) that the movements would have a scarcely appreciable effect. This point of view applies solely to submarines, thus giving to submersible vessels an extra reason for increasing the displacement, in addition to all those leading to the same tendency in surface ships. These, roughly speaking, are: Increase of speed, defensive and offensive power, seaworthiness, strength of structure, and radius of action. To obtain one or other or all of these things, each class of vessel represented in any navy in the world, has, following the trend of modern improvements, gradually been augmented in bulk. . . . With the submarine, one of the causes that will lead to its being increased in size will be the necessity of adding to the very meagre armament, for at present submersibles are the least armed war-ships in the world. In answering the question: "What direction will the increase of armament

take?" I shall make a statement which I do not expect one naval man in a thousand to uphold. It is this: The submarine, in common with the surface ship, must and will carry guns.

SPEED.

It is pointed out that another reason for increased size is the necessity for greater engine power, and twin propellers.

There is no reason why a large submersible should not have a surface speed of twenty-six or even thirty knots. We must remember that the Russian Nordenfelt submarine steamed at over twenty knots on several occasions. To the speed under water I attach but small importance; to the armoured and armed submersible of the future the present "totally submerged" speed of seven or eight nautical miles will be ample. All the quick work will be executed on the surface after the manner of torpedo-boat destroyers.

ARMAMENT.

Coming to the question of armament, the author remarks that:—

The submersible of, say, twenty-six knots will be able to pursue or fly from any battleship or cruiser, but will be open to attack by surface torpedo craft or other submersibles. The reason of this is that as the submersible increases in size so will the time required for complete submergence become longer. Hence, to protect itself against torpedo boats or destroyers during the filling of tanks, there must be a quick-firing armament, and the future submersible boat will carry a battery of 12-pounder and 3-pounder quick-firers, much as do our destroyers to-day. In fact, they will be destroyers, but capable of submergence, "fully," if badly pressed, "partly" for entering action, and thus presenting as small a target as possible. Here is where the armour deck is required, for the main work of the submersible being on the surface, her exposed parts must necessarily have adequate protection. It may be asked: "Then why not armour destroyers?" and the reply is that in a destroyer the full side would require to be armoured (and more heavily) to give the same protection as a curved armour deck in a submersible which is floating practically on a level with the surface.

Whilst increasing the armament by the addition of quick-firing guns, it will also become necessary to augment very considerably the present meagre complement of torpedo tubes. Obviously a submarine with a single tube must always remain an inferior weapon except for harbour defence.

PREVENTION OF ACCIDENTS.

The following suggestions are made for the safety of the crews employed on submarines:—

1. Our submarines are open from end to end, and hence a single breach fills the whole vessel. They might very easily be subdivided into seven or eight entirely separate compartments, communication between these being obtained by means of automatic water-tight doors, all capable of being closed from either compartment.

2. A detachable safety boat, such as proposed by Bourgois and Brun in 1862, and more recently by myself, capable of holding the entire crew and possessing sufficient buoyancy to rise when detached to the surface, could easily be fitted. This should have hatches in two or more separate compartments to add further to the chances of escape for the crew.

3. The conning tower of a submarine must in every case project from the deck line of the hull, and hence, when submerged, prove a source of danger, as the accident to *A1* has recently shown. When below the surface the conning tower is useless, and all operations connected with navigation could perfectly well be carried on within the hull proper of the submarine. This being the case, a horizontal sliding steel door might be fitted level with the deck, which, on reaching the depth at which the lid of the submarine became immersed, automatically shut off the conning tower from the interior, thus, in case of a leak therein, preventing a rush of water into the hull. Further, as the displacement of submarines increases, the conning tower could be rendered telescopic, and when not in use lowered to the level of the deck.

4. All our submarines are of positive buoyancy—that is to say, they possess a buoyant reserve which, were it not for the mechanism employed to keep them submerged, would bring them up to the surface. The reserve, however, is a very small percentage of the total displacement, and in the *A1* class is altogether inadequate. In certain foreign vessels one to three metal weights are recessed in the hull, each of which can be detached by a half-turn of a hand wrench. Obviously the sudden release of, say, a ton from the vessel's displacement causes it to shoot to the surface and, as has been proved by experiments in France, even a leak has not time to overcome this sudden lightening, if it be attended to immediately.

5. In the event of our submarines being entangled at the sea bottom, or for some reason unable to rise, their commanders possess no means of informing their friends above of their predicament. They should each be fitted with one or more small buoys capable of being freed by the withdrawal of a retaining iron rod, and, further, connected telephonically with the interior. This would allow the imprisoned men to explain their position and give their ideas as to the best methods to employ for their release.

6. All French submarines and the majority of those built by other Powers are fitted with four eye-bolts; two on either beam forward and two aft. After an accident a salvage steamer anchors in position above the submarine at low tide, and chains are let down on either side, clamp hooks at the ends being rapidly placed in the eye-bolts by divers. As the tide rises the hull is raised from the sea bottom, and the salvage steamer makes its way into harbour. Indeed, owing to the density of sea water, it should be possible, having once secured a firm hold, to haul the submarine

up by steam capstans until the conning tower touched the keel of the salvage vessel; like this the submarine might be taken into dock.

DISPLACEMENT.

To carry all these things—armour, guns, larger engines for increased speed, more room for fuel, extra torpedo tubes, safety appliances, etc.—a greater displacement is essential. Our latest vessels, *A2*, *A3*, *A4* have been given a second torpedo tube and a higher speed by six knots than their forerunners, but to obtain this the displacement had to be nearly doubled. Yet even their 200 tons is not sufficient —France is already approaching the 500—and I hope soon to hear of submersibles of six to eight hundred tons (submerged displacement) being ordered. These would be approximately the size of our destroyers, for, be it remembered, if one of them were submerged to the deck, at least 250 tons would be added to the weight of water displaced.

CRITICISMS.

The paper was criticised by Captain Bacon, who considered that the paper was not one which should be given the cachet of having been read before that Institution without serious objection being taken to many of the statements it contained. No distinction, he remarked, had been drawn by Mr. Burgoyne between surface and submerged speed. If they had the *maximum* of surface speed they could not get the *maximum* of submerged speed. In the same way, range of action on the surface was antagonistic to range of action below the water. The whole future of the submarine depended upon the proportion of balance which was desired in these and other respects. The most important consideration which tended to limit the size of submarines had not been mentioned at all—the question of submerged horse-power. As the size was increased the battery power must be increased *pro rata*, so as to preserve the speed that the smaller boats originally had. That was really the whole question on which the size of submarine boats hinged. The lecturer's statement that the submarine of the future would carry guns had nothing new about it. That submarines would carry guns was certain; the only question was: How would they carry them? On the question of providing safety appliances, he chiefly took exception to the lecturer's use of the word "easily." If such things could be easily done they would be done. They had been told that watertight compartments could be put in very easily. He denied that that was the case. There was an enormous number of considerations which had to be taken into account.

Among other speakers, Admiral Sir E. Fremantle thought they should be grateful to Mr. Burgoyne for the information on submarine boats laid before the meeting. As regarded the main facts stated—quite apart from the theories—he thought that they might depend on them. He did not himself believe that they would ever have submarines with guns to any extent, and it would seem to be impossible to have them with an extreme surface speed. If the boats were to have great speed they could not have equal strength or capacity in other respects. He was convinced that the Admiralty were quite right in keeping what they were doing as secret as possible.

The Chairman (Sir William White) also criticised the paper. Incidentally, he said it was an important matter, in relation to submarine vessels, that they should keep their level or depth. That problem had been one of considerable difficulty in the past, but Captain Bacon, who possessed such large experience of the subject, had informed them that it had been surmounted. It was not so long ago, however, when it was a real difficulty and one involving considerable danger. In that connection it was important to notice that the question of speed below the surface could not be dissociated from the risks of going to very considerable depths in short times, if high speeds were attempted and there was the least departure from a level keel. He believed that it was a simple fact that Mr. Holland, the American inventor, who had devoted many years of his life to this subject, was always particularly careful not to make his experiments in deep water. Everything in this matter, as in fact in all ship construction, depended on estimates of weight. The civil architect and engineer who did constructional work on land had to think of strength and stability and weight; he had not to float the thing, but the shipbuilder had, and he must always ask himself: "Will it float?"

RAILWAY SURVEYS AND DESIGN IN NEW COUNTRIES.

IN the course of a paper on the above subject contributed by Mr. Percy Gilbert Scott, at a meeting of the Society of Engineers, the following notes are given on a survey in which the author was appointed one of the senior assistant-engineers under Messrs. Shelford and Son, Consulting Engineers to the Colonial Government for West African Railways:—

The country through which the railway runs from Sekondi on the sea coast, to Tarkwa (a distance of nearly forty miles), is of a very difficult and mountainous character, consisting of steep conical hills, three ranges occurring just before entering Tarkwa. The country is very unhealthy, and the only means of transport was by carriers, there being no horses or cattle in the district. It was impossible to decide the nature of the country from the mere inspection of the ground on account of the virgin forest and thick undergrowth, which completely shut out the view. Every line surveyed had to be cut through the bush with the exception of a few bush paths, which, however, had to be cleared before survey lines could be run on them. The prismatic compass, miner's dial, and 66 ft. steel tape, were used in making the preliminary survey. All rivers and streams were surveyed for considerable

distances on each side of the base lines, and a proper map of the district was made, cross sections being taken at rather long intervals; each survey line, cross section and course of river and stream being previously cleared.

A contoured survey plan was then prepared, and the general direction of the route marked on it. This was used as a base line for further and more detailed operations; the straight lines and long chords of curves being run in with a theodolite and cross sections taken at every chain (66 ft.), and in exceptionally difficult portions at intervals of half a chain. Owing to the difficult nature of the country, several other base lines in the neighbourhood of the proposed route had to be used and cross sections taken off these. A complete contoured plan of the country was then prepared, which gave a wide range of selection for the actual line of the railway. The gauge is 3 ft. 6 in., with a maximum gradient of 1 in 50 for straights, and a minimum curve of 5 chains (330 ft.) radius. By adopting such heavy gradients and sharp curves, tunnels, and viaducts were avoided, and a good hard formation was obtained, the line being designed in such a manner that adjacent banks and cuttings were made to equalise as far as possible.

Gauges.

On the question of gauges, the author says:—

The subject of gauge is a very important though conflicting one, and engineers by no means agreed as to which is the best gauge suitable for railways. The 4 ft. 8½ in. gauge, though based on no scientific principles, is found to answer admirably for all purposes. Too great importance cannot be attached as to the continuity of gauge, as break of gauges in connection with important lines means loss of time and money in transhipment. To instance an example of the evil of break of gauge, the author will quote Mr. Ross-Johnson, traffic manager of the Madras Railway, and one of the witnesses before the recent Railway Commission appointed by the Government of India regarding the linking of India and Ceylon. Mr. Ross-Johnson declares: "That not only should the line linking Ceylon and India be broad gauge, but such a line and the conversion of certain metre sections to broad gauge was necessary to secure convenience of communication between Northern India and the large cantonments in the South. As it was, the Government sent troops from Bangalore 312 miles round, to avoid the inconvenience of gauge." It may be as well to mention here that the broad or standard gauge of India is 5 ft. 6 in., and the other principal gauge is the metre. In India there are a number of advocates in favour of the latter gauge, though lines on that gauge can never compete in speed with those on the broad gauge, and it is doubtful whether they are as efficient in the handling of large quantities of goods. In the author's opinion, all main and important lines should be on the standard gauge, and the less important on narrow gauges, which, in their turn, should be converted to the standard gauge as traffic develops. It may also be necessary, for political reasons, to have the gauge of a country different to those of other countries in its neighbourhood.

The following is a list of the principal gauges adopted on railways in various countries:—

TABLE OF GAUGES.

Countries.	*Gauges.*
England and Europe generally	4 ft. 8½ in.
Ireland..	5 ft. 3 in.
Canada	5 ft. 6 in. and 4 ft. 8 in.
Australia	3 ft. 6 in.
United States	4 ft. 8½ in.
British India	5 ft. 6 in. & 1 metre.
Egypt	4 ft. 8½ in. & 3 ft. 6 in.
South Africa, Gold Coast, Lagos, and New Zealand	3 ft. 6 in.

COMING EVENTS.—JULY.

7th.—Ipswich Engineering Society visit the works of the British Xylonite Company, Brantham.

11th.—Birmingham Association of Mechanical Engineers: Annual Engineering Excursion.

19th.—His Majesty the King and Queen Alexandra inaugurate the new dock works at Swansea.

21st.—His Majesty the King and Queen Alexandra open the Birmingham Welsh Water scheme at Rhayader.

21st.—Institute of Mining and Metallurgy meet at Burlington House, 8 p.m.

23rd.—Midland Counties Institution of Engineers meet at Barnsley.

SOME RECENT PUBLICATIONS.

"ENTROPY."

Or Thermodynamics from an Engineer's Standpoint, and the Reversibility of Thermodynamics. By James Swinburne. Archibald Constable and Co., Ltd. 4s. 6d. net.

In this volume Mr. Swinburne has set himself to give a clear definition of entropy, and students should be grateful to him for the performance. Of his own difficulties in meeting this problem, Mr. Swinburne speaks with characteristic frankness. "As a young man," he says, "I tried to read thermodynamics, but I always came up against entropy as a brick wall that stopped my further progress. I found the ordinary mathematical explanation, of course, but no sort of physical idea underlying it. No author seemed even to try to give any physical idea. Having in those days great respect for textbooks, I concluded that the physical meaning must be so obvious that it needs no explanation, and that I was especially stupid on that particular subject. (Everyone who studies by himself knows he is particularly stupid in certain directions, and is constantly realising new limitations.) After a few years I would tackle the subject again, and always I was brought up dead by the idea of entropy. I asked people, but I never met anyone who could tell me, and I met one, an engineer, who admitted that he did not know. Not only could I get no physical idea of entropy, but the definition of entropy and the statements about it did not make sense as soon as one tried to understand irreversible changes. Later on, instead of making the common mistake that elementary books are easy to understand, I got into the study of irreversible thermodynamics by the road of physical chemistry, and found that my previous troubles were due to inaccurate definitions and faulty analogies on the part of writers who had an incomplete grasp of thermodynamics. Having once got accurate and consistent definitions, it is not so difficult to get some sort of physical idea of entropy."

"HAULAGE AND WINDING APPLIANCES USED IN MINES."

By Carl Volk. (Based on the works of J. von Hauer.) Translated from the German by Charles Salter. Scott, Greenwood and Co., D. Van Nostrand Co. (New York). 8s. 6d. net.

The author gives a comprehensive view of a subject to which a good deal of attention has been paid in PAGE'S MAGAZINE. It is designed for students in mining schools, young technicists, and mine managers, and treats in a concise manner upon the subjects dealt with in the large work on winding engines by Julius von Hauer, as follows: Ropes—Haulage Tubs and Tracks—Cages and Winding Appliances—Winding Engines for Vertical Shafts—Winding without Ropes—Haulage in Levels and Inclines—The Working of Underground Engines—Machinery for Downhill Haulage. There are many excellent diagrams and plates. Chapter V.—Winding without Ropes—is condensed into twenty-one lines. It describes Blanchet's "pneumatic" system of winding, and the method proposed by Mähnert. Blanchet inserts in the shaft a pipe (or, for double winding, two pipes), about 60-80 in. in diameter, reaching from the lowest pit eye to bank. Into these pipes fit the cages, which are mounted on large pistons with leather packing. The cage is raised by exhausting the air at the top of the pipe, and the down trip is accomplished by gravitation, the rate of fall being regulated by throttling the after-flow of air. By this means the ventilation of the mine is effected at the same time. So far, the system has only been tried once, namely, at the Hottingue shaft, near Epinac. In the Mähnert system, two pipes are built in the shaft, these being filled with water, and connected at the bottom by means of a lock chamber. The load is inserted in an iron vessel, which ascends to the surface in the upcast pipe, whilst the emptied and suitably weighted vessels sink down the intake pipe. This method has not been tried in practice.

"ELECTRIC TRACTION."

A Practical Handbook on the Application of Electricity as a Locomotive Power. By John Hall Rider. Whittaker and Co. 10s. 6d. net.

Mr. Rider presents the subject in such an attractive manner and has been so careful to avoid any abstruse mathematical calculations that his book should be read with interest and profit by many who are not actually engaged in electric traction work, as well as by the specialist. The work is subdivided as follows: Introduction—Generating Plant—Switch Gear—Distribution—Motors—Controllers—Rolling Stock—Permanent Way—Overhead Systems—Conduit Systems—Surface Contact Systems—Accumulators—Combined Lighting and Traction Stations—Electric Railways.

In the author's opinion the adoption of the conduit is only justified under one or other of the following circumstances, viz.: (1) When the traffic over the lines is so great that the heavy fixed capital charges do not make any serious addition to the costs per car mile. This is a condition of things only met with in Metropolitan cities, and, after all, is no reason why the overhead system should not be used. (2) When the powers for the tramway can only be obtained on the condition that the conduit is used. (3) When the system of lines is so complicated that the overhead construction becomes cumbersome and dangerous. Both (2) and (3) are again controlled by (1), since, unless the traffic can be guaranteed, the line cannot pay, and had, therefore, better not be constructed.

Of surface contact systems, he remarks that while they are almost perfect in theory, yet they are most difficult to design, and work satisfactorily in practice. Whether surface contact systems have a future or not is very difficult to prophesy. Their only justification is that they get rid of the overhead wires. They are certainly cheaper in construction than the conduit system, averaging from £8,000 to £10,000 per mile of single track, including rails and paving. They necessitate far less disturbance of the surface of the road during construction, as it is not necessary to excavate lower than for the ordinary concrete foundations under the track rails. The weak point, in all such systems, is the use of a switch for each individual contact stud.

(*Owing to pressure upon our space a number of reviews are unavoidably held over.*)

OUR DIARY.

May.

21st.—Opening of the Annual Council Meeting of the Northumberland Miners' Association.

27th.—The value of the Transvaal imports during the first quarter of the present year amounted to £3,527,213; the Customs receipts for the same period amounted to £413,000.

28th.—Launch of the steel screw steamer *Waddon* at Hebburn-on-Tyne.

30th.—The South Wales Coalowners' Association meeting at Cardiff adopts the recommendation of the owners' representatives on the Conciliation Board, that Mr. Fred L. Davies should be appointed president at a remuneration of £2,000 a year.—The new Cape liner, *Kenilworth Castle*, sails from Southampton on her maiden voyage.—Opening of the Newport Corporation Waterworks at Wentworth.

31st.—The British and American Mechanical Engineers' Convention opens in Chicago.

June.

1st.—Brazil denounces the commercial treaty of 1891 with Peru.—Mr. G. Balfour, M.P., receives a deputation at the Board of Trade from the City Corporation and the Thames Conservancy, who urge that an official inquiry should be held as to the suggestion for a Thames Dam scheme.—The Queensland Treasury returns show that the excess of revenue over expenditure for the eleven elapsed months of the financial year is £500,000.

2nd.—The Thames Steamboat Company open a service of express steamers between Westminster and Greenwich.

3rd.—The London Traffic Commission hold their last public sitting.

6th.—The German Engineers' Association unanimously confers the Grashof medal on Mr. Parsons, of Newcastle-on-Tyne, and M. de Laval, of Stockholm.—The Haulbowline Dockyard tug *Thistle* sinks in Queenstown Harbour.—Members of the Royal Institution place on record their sincere thanks to Mr. Andrew Carnegie for his donation of £1,200, to enable Professor Dewar and Mr. R. A. Hadfield to prosecute their investigations on the physical properties of steel and other alloys at low temperature.

7th.—The Inter-Colonial Council at Pretoria, discussing the question of the construction of new railways by private enterprise, decides, in opposition to Lord Milner, against any Government guarantee being accorded to the undertakings.—It is reported that the Broughton and Plas Power Company will shortly reopen the Vron Colliery, which formerly gave employment to 500 men.

8th.—Mr. A. H. Burgoyne reads a paper at the United Service Institution on "The Future of the Submarine Boat."—A Bill for the reorganisation of the Brazilian Navy, laid before Congress to-day, provides for the purchase of 28 ships. The Bill specifies that English yards are preferable for the construction of the vessels.

9th.—Death of Sir William Henderson, of Aberdeen.—The Marylebone Borough Council decide to apply to the L.C.C. for their sanction to borrow £436,500 for the erection of an electric generating station, etc.

11th.—Sir F. Dixon-Hartland, M.P., Chairman of the Thames Conservancy Board, opens the new lock at Teddington.

13th.—Publication, as a Parliamentary paper, of the committee's report on the Board of Trade—it is recommended that the President's salary should be raised to £5,000, and that his title should be changed to that of Minister of Commerce and Industry.

14th.—Launch of the first-class armoured cruiser *Duke of Edinburgh*.—A House of Lords Committee approves of the Torquay Tramways Bill, which proposes the introduction of a new system of electric traction.

15th.—Appalling disaster in New York Harbour—several hundred lives lost consequent upon the burning of the steamer *General Slocum*.

16th.—The new electrical steel swing bridge, designed to carry the railway for the Transatlantic boat trains across Dover Docks, is swung into position.

17th.—The Gordon-Bennett Motor-car race is held in the neighbourhood of Homburg.—Sir Percy Girouard, the Transvaal Commissioner of Railways, tenders his resignation.—It is announced that the Glasgow steamer *Kirkdale* has been sold to the Japanese for the net sum of £21,500.—The torpedo-boat destroyer *Sparrowhawk* strikes an uncharted rock, and sinks, off Chesney Island.

20th.—The Thames Conservancy Board approve of the construction by the Thames Steam Tug and Lighterage Company of a covered barge dock at Lots Eyot, Brentford.—Dr. Kerr's Yacht *Valdora* wins the Dover to Heligoland race.—Lord Salisbury presides at the King's College Annual Dinner.

21st.—Opening of the Royal Agricultural Show.—The first batch of Chinese coolies for the Rand, 300 in number, are despatched by train from Durban.

NEW CATALOGUES AND TRADE PUBLICATIONS.

Allgemeine Elektricitats-Gesellschaft, Berlin, forward a circular illustrating their latest arc lamps.

Herbert Perkin, Prudential Buildings, Leeds.—Under the title, "Labour Savers, Time Savers," Mr. Perkin has produced a freely illustrated list of hack saws, valuable to engineers, shipbuilders, and the metal trades.

C. Redman and Sons, of Pioneer Iron Works, Halifax, forward a finely illustrated catalogue of High-grade Machine Tools, which also includes description and views of the Pioneer Iron Works, under the title "A Modern Yorkshire Machine Tool Works."

Diplock's Patent Traction Engine Haulage Syndicate, Ltd.—From the circular which reaches us from this firm we are reminded that the pedrail tractor, as described in PAGE'S MAGAZINE some months ago, has been exhibited at the Royal Agricultural Show. Further reference to this matter will be made in our next issue.

W. J. and C. Tyack, Ltd., Camborne, forward details of Bickford's patent oil crucible furnaces for melting brass, iron, gold, etc. An important feature of these furnaces is that any waste of kerosene can be used, and it is claimed that 40 lb. of brass can be melted in 30 minutes with half a gallon of waste oil, starting all cold.

F. W. Braun and Co., Los Angeles, California, forward a small pamphlet entitled "Annealing, Hardening, Tempering, and Case Hardening," the idea being to incorporate some valuable hints on these operations, while at the same time calling attention to the advantages of Braun's Portable Forge and Tempering Furnace.

The Northampton Accumulator Company, West Bridge Works, Northampton, forward a very handy pamphlet giving complete details of their N.A.C. accumulators, with working instructions, etc. The firm manufactures secondary batteries for lighting and central station use, also for motor cars and every description of electric traction.

Jessop and Appleby Bros., Ltd., Leicester and London, have issued a new edition of their illustrated pamphlet relating to electrical cranes of standard, and a few special, types, also electrically driven winches, lifts, concrete mixers, and pile drivers. Some useful information is included on the subject of small electric lighting and power installations.

The Brush Electrical Engineering Company Ltd., Falcon Works, Loughborough.—"An all-British Line," is the title given to this firm's latest production. The interior is a folding strip showing ten items of rolling stock in line. These include a steam and electric locomotive, electric railway carriages, a rail watering and cleaning electric car, and various forms of electric trams.

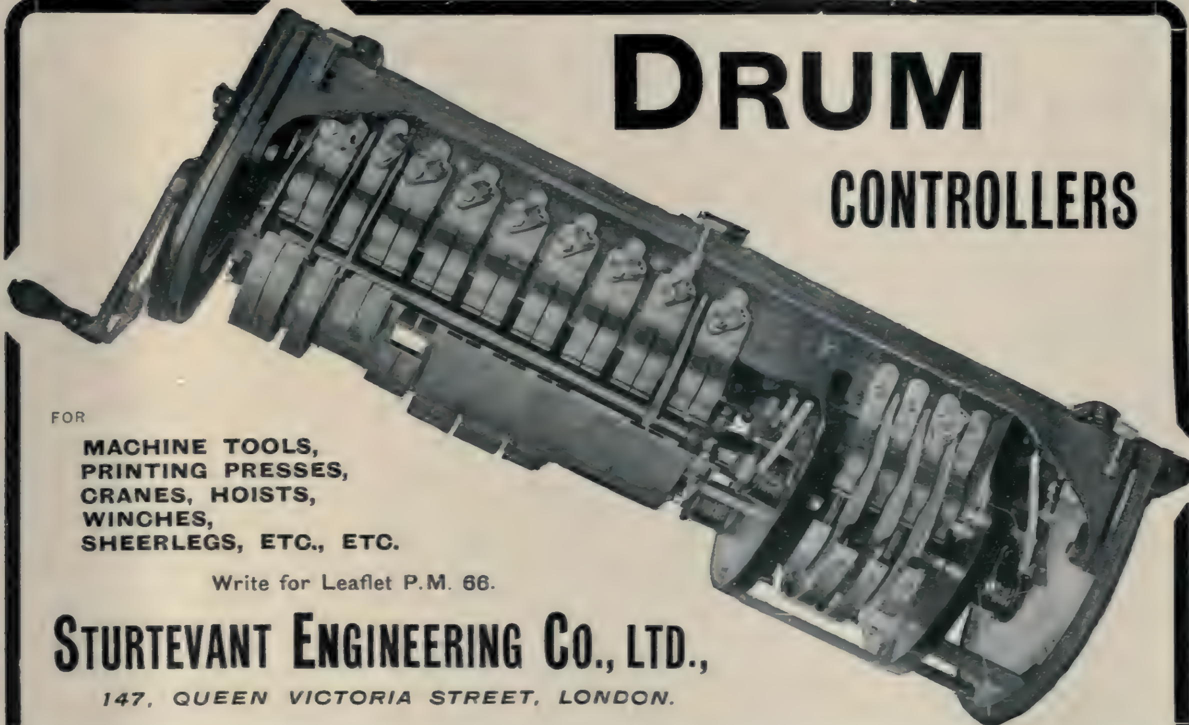
British Westinghouse Electric and Manufacturing Company, Ltd.,—Pamphlet No. B1072 describes and illustrates the Westinghouse No. 90M Tramcar Controller, and gives a good general idea of the extent to which Westinghouse Tramway Equipments are used in Great Britain. Pamphlet No. B1080 gives the salient points of the No. 200 Tramway Motor, which has been designed to meet the demand for a motor of thoroughly sound construction and medium power, for service on cars of moderate speed and seating capacity.

Holden and Brooke, Ltd., of Sirius Works, West Gorton, Manchester, forward List No. 66, describing and illustrating Brooke's Patent Motor Wagon Injector, and List No. 67, which is concerned with Brooke's Patent "P.S." (Protected Seat) Valve, and other special steam valves. A small folding pamphlet calling attention to the remarkable possibilities of Brooke's Patent Separator or Steam Dryer has also been received.

Croft and Perkins, Great Northern Works, Bradford.—An illustrated circular, printed in two colours, of their new type rim friction clutches. Special features of these are stated as follows: Greatest possible driving power, simplest method of adjustment, greatest possible clearance when out of clutch. The firm also forward the latest edition of their catalogue and price list of power transmitting machinery, etc., superseding all previous lists.

David Bridge and Co., Castleton Ironworks, Castleton, Manchester.—An eight-page circular issued by this firm contains a great deal of compressed information *re* Heywood and Bridge's improved patent friction clutch. The firm make a speciality of complete gearing and hauling installations, and some instructive illustrations are included showing the actual application of these clutches. This firm also sends a pamphlet illustrating and describing Stratton's patent four-way hydraulic valve, and ask "Have you ever racked your brain to think out a valve which would not go wrong, and which anyone with two minutes' tuition could control, and which would never let the water pass"? It is claimed that Stratton's patent valve fulfils these conditions.

The Blake and Knowles Steam Pump Works.—This firm is issuing a special catalogue of condensing apparatus for stationary and marine engines, etc., in order to afford more detailed information regarding this prominent branch of the business than is possible in their regular catalogue. The booklet is well designed and illustrated, and in small space affords a great deal of special information, while room has also been found for a number of useful tables on the economy of high grade steam engines, mean effective and terminal pressures, weight and comparative fuel value of wood, weight and capacity of different standard gallons of water, etc. For the independent condensing apparatus produced by the firm, the following advantages are claimed: 1st. That it will save from 20 to 30 per cent. in steam when applied to non-condensing steam engines, or will give an increase of power of corresponding amount. 2nd. Will quickly produce and steadily maintain the highest vacuum desired with least amount of injection water and power to operate the air pump. 3rd. Requires no expensive foundation and occupies but little floor space. Can readily be attached and placed in any position most convenient—under the engine-room floor, if desired. 4th. Being independent, it can be operated and a vacuum formed before the engine is started—an important feature! The speed of the pump can be readily adjusted to meet the demands of the steam-engine, no matter how variable the load—an impossibility with connected air-pumps. 5th. Will run smoothly and noiselessly, relieving the steam-engine from just so much *drag*, especially where the connected air pump is made larger (as is generally the case) than is actually necessary.



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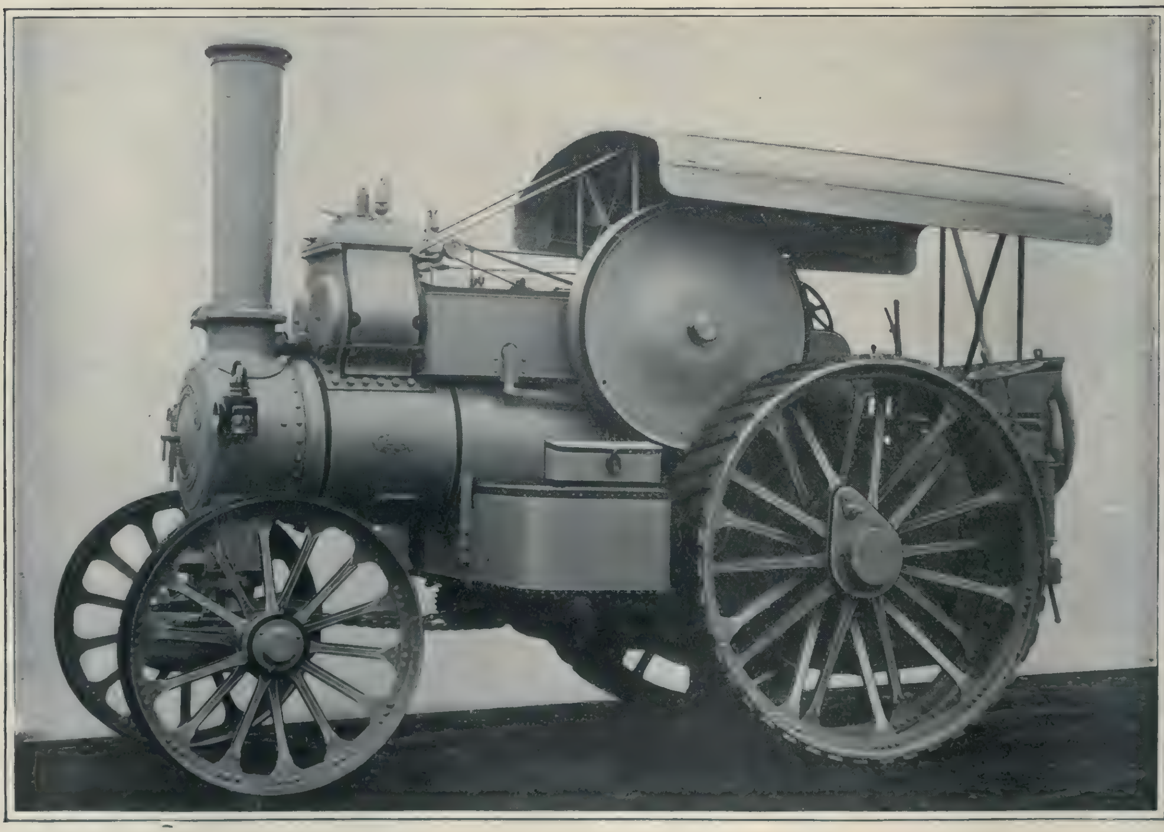

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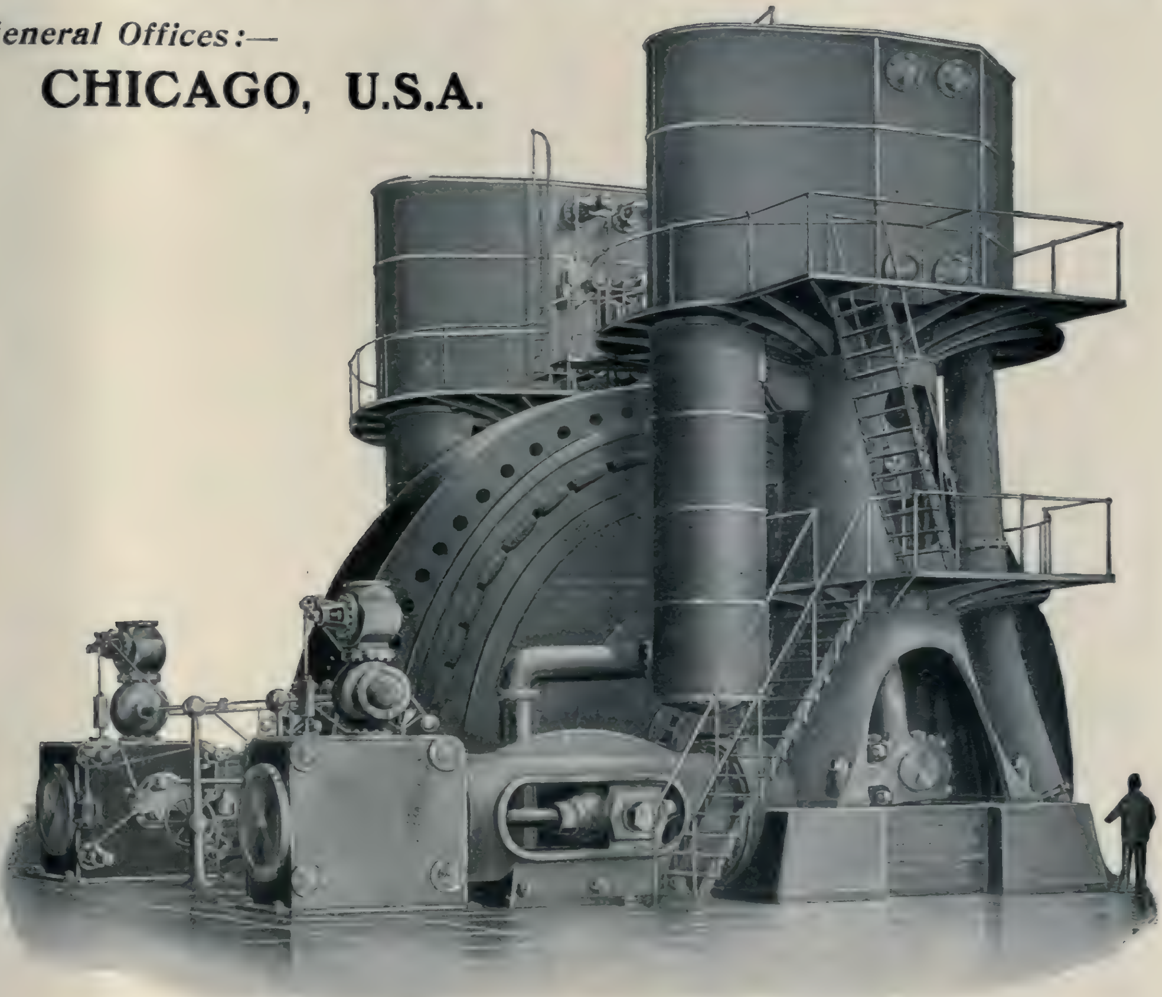

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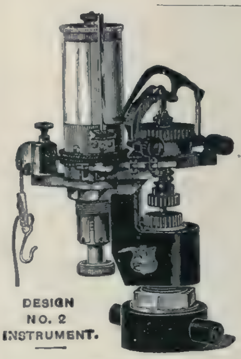

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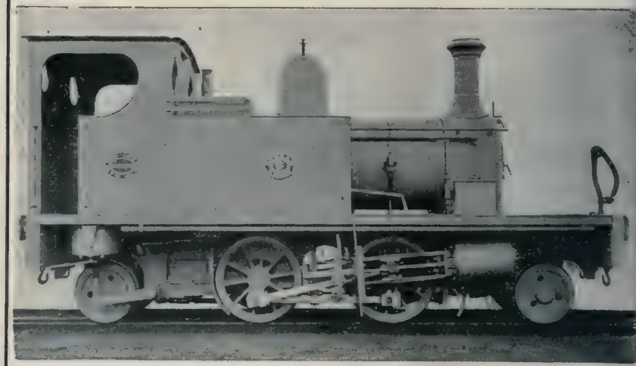

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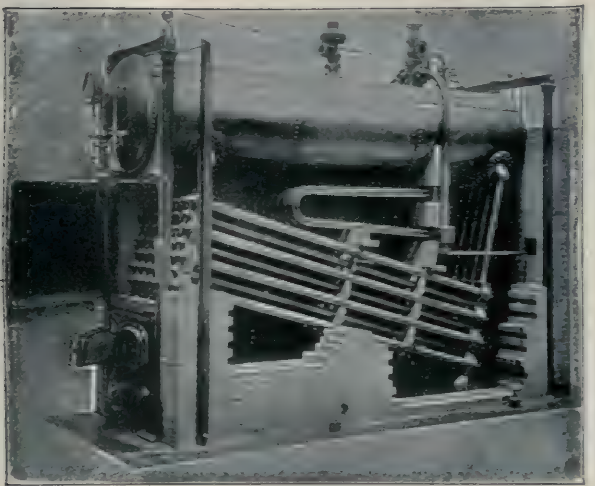

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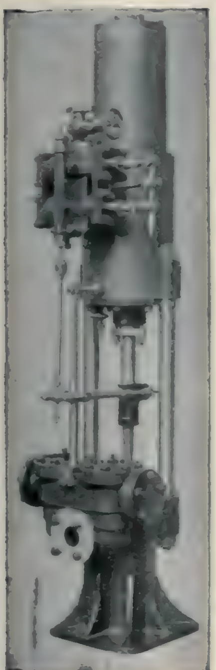

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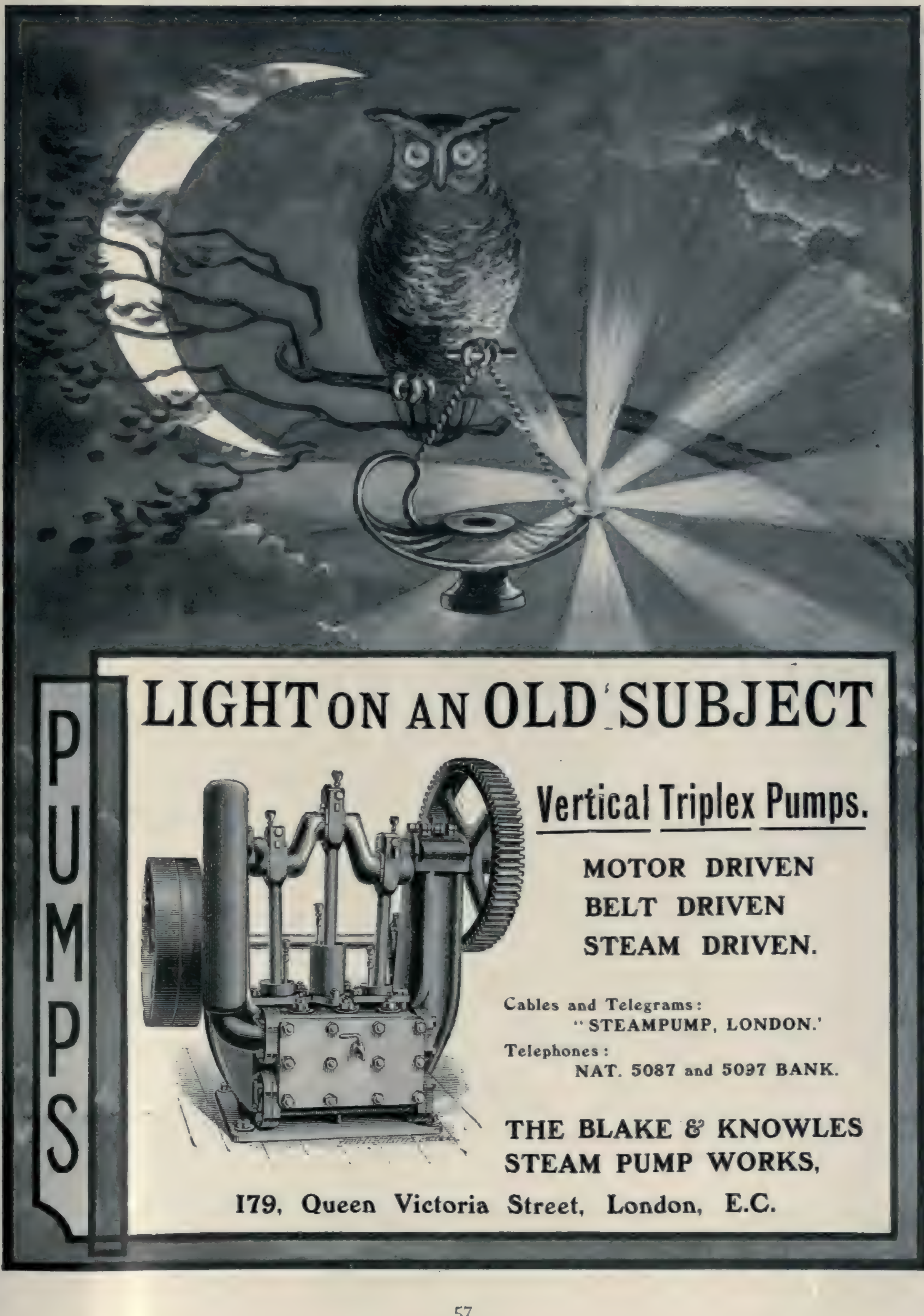
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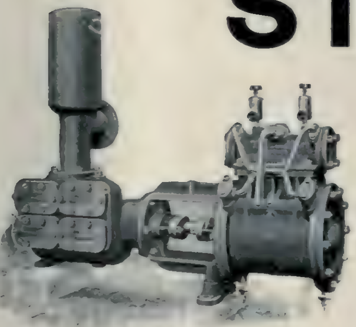

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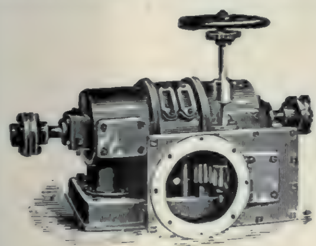

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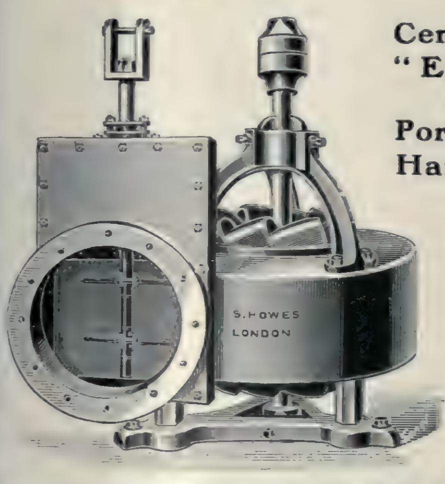

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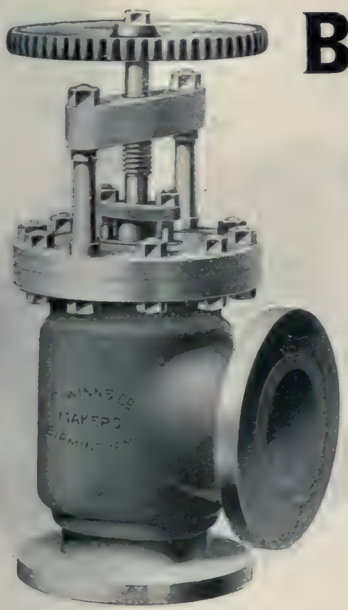

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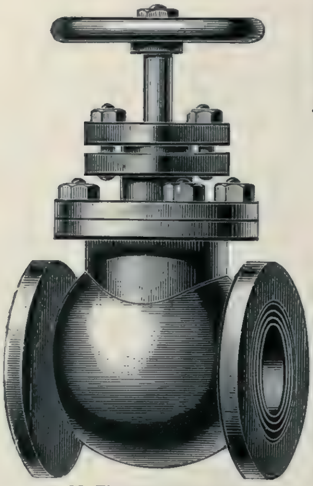

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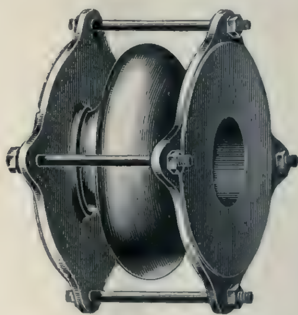

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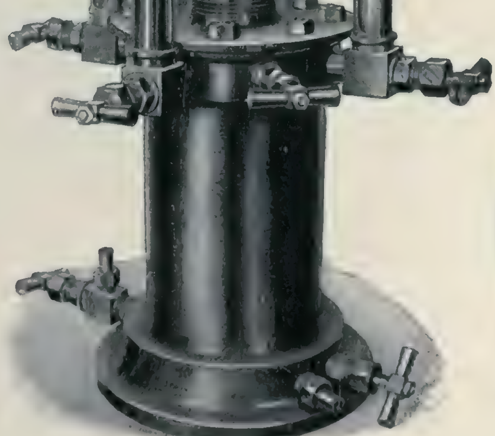

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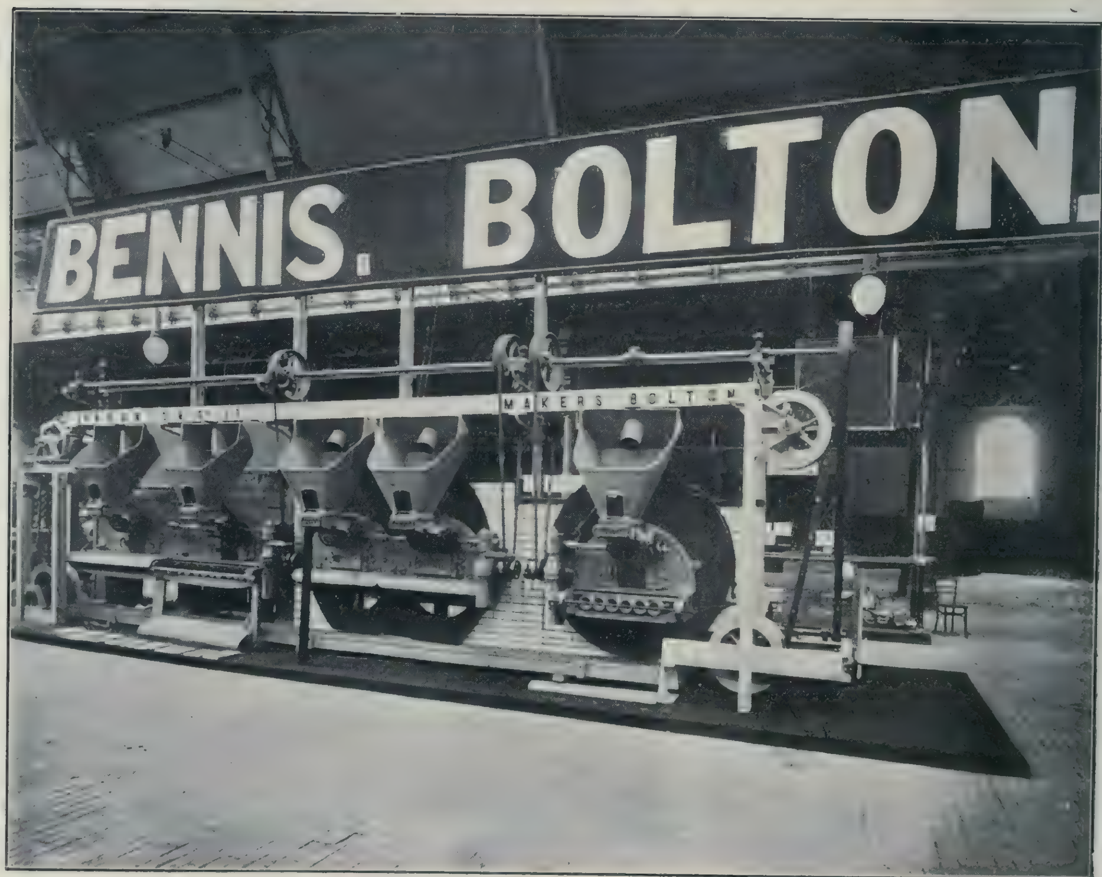

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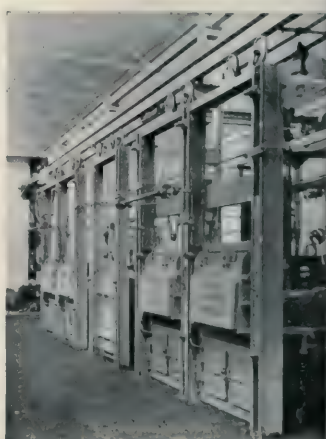

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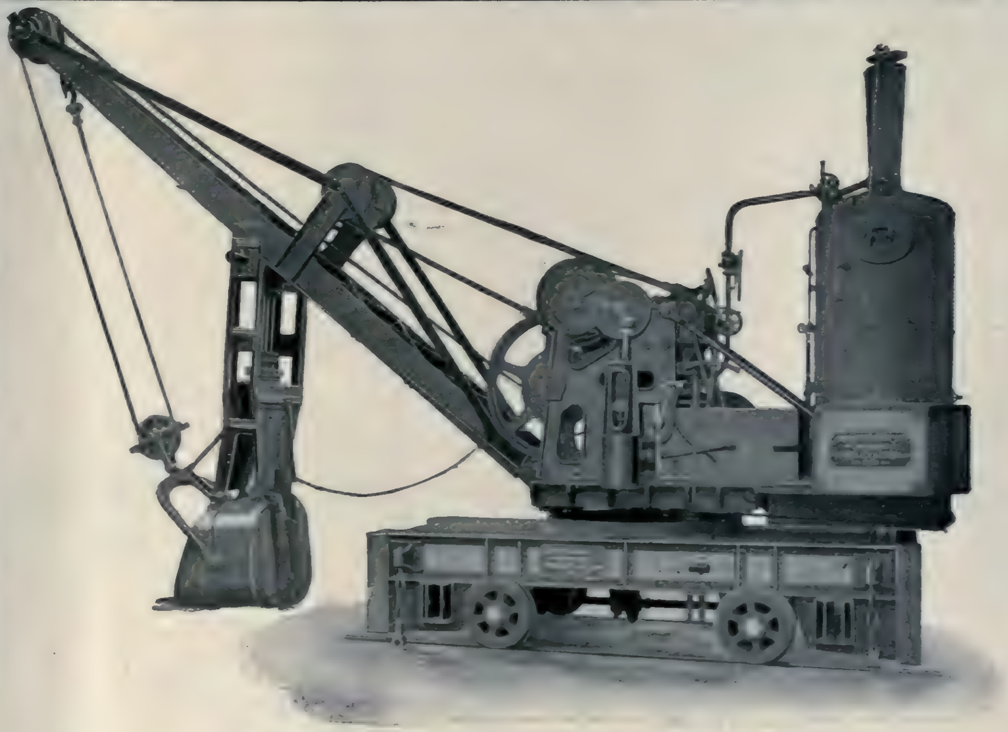

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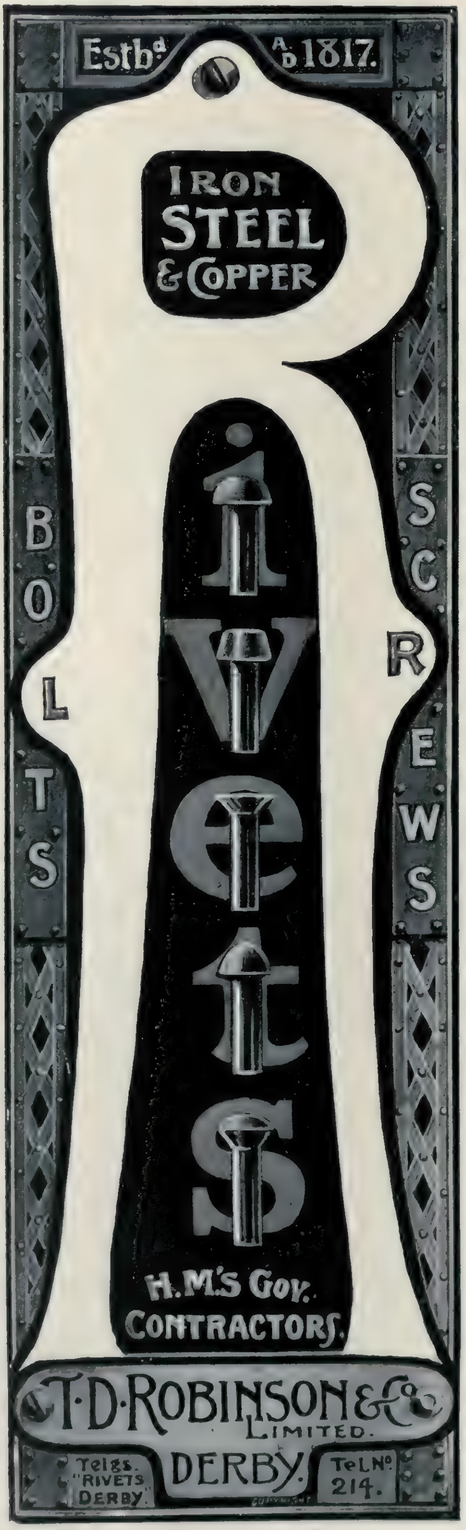
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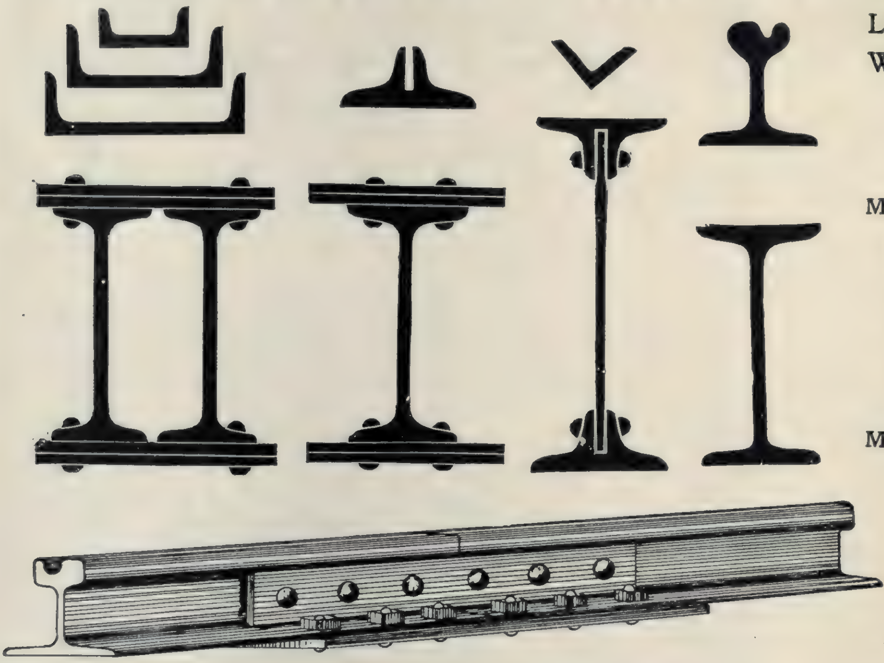

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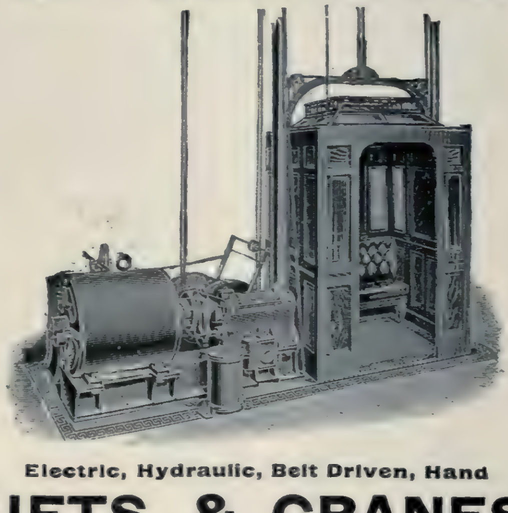

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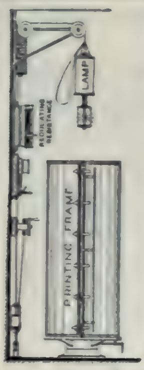

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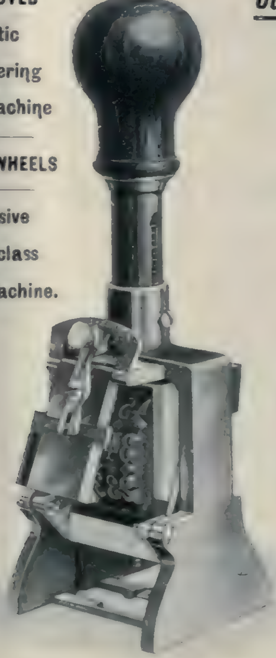

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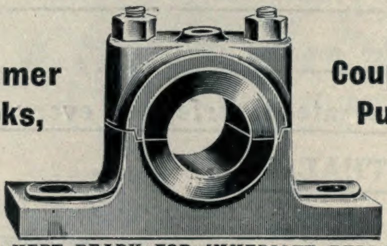

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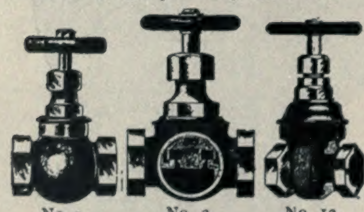

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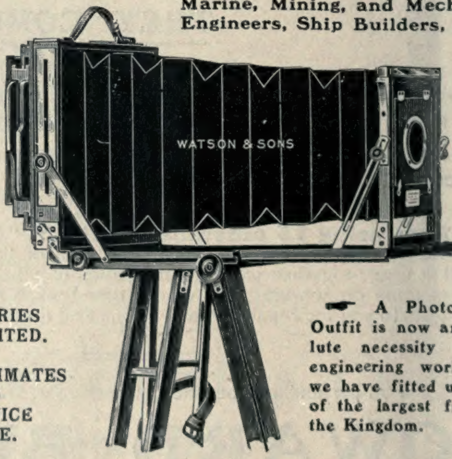

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